SWCA
ENVIRONMENTAL CONSULTANTS

Regional Athletic Complex Riparian Restoration Plan

Prepared for
MGB+A The Grassli Group
and
Salt Lake City

Prepared by
SWCA Environmental Consultants

June 14, 2010

SALT LAKE REGIONAL ATHLETIC COMPLEX
RIPARIAN RESTORATION PLAN

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EXECUTIVE SUMMARY

This plan outlines the restoration of an urban riparian area located on approximately 44 acres along the Jordan River between 2000 North and the Davis County Line in Salt Lake City, Utah. The creation of this restoration area (RA) will be a result of the development of Salt Lake City's planned Regional Athletic Complex (Athletic Complex). The riparian restoration on the east side of the river is being completed as part of this plan in conjunction with existing plans for Jordan River Parkway construction.

Restoration is the process of returning a degraded habitat to a healthy, self-sustaining ecosystem with natural function and a predominance of native species. This restoration plan describes the RA's current degraded condition and identifies methods to improve its ecological function and capacity to support desired native species.

Once the restoration budget for the RA is determined, a detailed implementation and management plan, based on the restoration designs and strategies described in this restoration plan, will be completed prior to streambank contouring, weed treatment, or planting in the RA. The implementation and management plan will provide a detailed planting plan, seed mixes, irrigation design, and construction drawings for streambank modifications. It will also provide cost and availability of plants and seed mixes, integrated weed treatment information, detailed monitoring and maintenance protocols, and recommended types and levels of access to the RA.

In keeping with Guiding Principles of Blueprint Jordan River (Envision Utah 2009), the restoration goal for this RA is to improve riparian and upland features and functions, including wildlife habitat and downstream water quality, while balancing the needs for development, recreation and public access in adjacent areas. This goal can be accomplished via the objectives stated in this plan.

Part of this plan is to provide improved habitat for migratory bird species by enhancing and managing habitat for ten priority species. The habitat requirements of these priority species will inform the restoration strategies and success criteria for the RA. The focus on specific bird species ensures that restoration efforts will enhance habitat components needed by these species as well as create habitat suitable for other wildlife species with similar habitat requirements.

This plan details strategies for improving the existing conditions and ecological function in the RA through the restoration of the following six habitat types: off-channel wetlands (8.0 acres), graminoid slope wetlands (0.7 acres), emergent bench wetlands (2.0 acres), riparian forest complex (5.9 acres), upland grasslands (19.1 acres), and upland shrublands (7.4 acres). Currently, the RA has areas of all of these habitat types except for graminoid slope wetlands. In some areas, the existing habitat will be improved through weed removal and native plantings. In other areas, more extensive restoration will be required including stream bank contouring. Restoration techniques that will be used in the RA include public involvement, creation of physical buffers, weed management, excavation, planting, and irrigation. This plan also provides general monitoring, evaluation, and maintenance requirements for migratory birds, weeds, and native vegetation.

The installation of interpretive signage at the trailhead along the east side of the Jordan River in the RA will provide educational opportunities and help foster environmental stewardship through better understanding of the ecology of the Jordan River. A multi-paneled, kiosk-type sign at the trailhead will feature interpretive material on native plants, wildlife and, noxious weeds.

This plan was prepared by SWCA and reviewed by a public steering committee of professionals and concerned citizens. All of the recommendations received from this committee that were relevant to the restoration goals for the RA have been incorporated in this plan.

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1.0 Introduction

This plan outlines the restoration of approximately 44 acres located adjacent to the Jordan River between 2000 North and the Davis County Line. This urban riverine area consists of approximately 23 acres on the west side of the Jordan River and 21 acres on the east side (Map 1). The creation of this restoration area (RA) will be a result of the development of Salt Lake City's planned Regional Athletic Complex (Athletic Complex). Work by Salt Lake City and its landscape architecture consultant, MGB+A The Grassli Group, has resulted in clustering sports fields on the west side of the property while preserving a riparian/upland buffer along the river's western boundary. The riparian restoration on the east side of the river is being completed as part of this plan in conjunction with existing plans for the Jordan River Parkway.

For the purposes of this plan, restoration is not the process of returning a site to its pre-human or pre urban condition. Restoration is the process of returning a degraded habitat to a healthy, self-sustaining ecosystem with natural function and native species. Restoration at the system level, (i.e., Jordan River), is beyond the scope of this plan because of limitations on returning the current ecological structure (plant diversity) or function (hydrology) to historic watershed condition (Williams 1997). This plan describes the restoration area's (RA) current degraded condition and identifies strategies to improve the habitat structure and function. However, it is important to recognize that the potential of the site to be truly self-sustaining is compromised by its proximity to disturbance and the highly regulated hydrology of the Jordan River. For this reason successful and lasting restoration will require ongoing stewardship to prevent a return to the current degraded state.

Once the restoration budget for the RA is determined, a detailed implementation and management plan, based on the restoration designs and strategies described in this restoration plan, will be completed prior to streambank contouring, weed treatment, or planting in the RA. The implementation and management plan will provide a detailed planting plan, seed mixes, irrigation design, and construction drawings for streambank modifications. It will also provide cost and availability of plants and seed mixes, integrated weed treatment information, detailed monitoring and maintenance protocols, and recommended types and levels of access to the RA.

The restoration itself may serve multiple needs including Section 404 compliance, advanced mitigation, creation of outdoor educational opportunities, and enhancement of the natural and human environment of Salt Lake City. All applicable state, county, and city permits will be obtained and complied with during the creation of the implementation and management plan for this project.

1.1 The Restoration Plan in an Historic Context

A review of historic records shows significant modification to conditions on the site over the last 135 years. A survey conducted by Nathan Kimball in 1875 identifies the Jordan River on the west side of the proposed restoration area (Utah Division of Wildlife Resources 2003). The larger Regional Athletic Complex parcel itself is described as "willow bushes" extending east from the banks of the river approximately 0.5 miles to the shore of Hot Spring Lake (see Map 2). Although the survey map delineates only a single channel of the Jordan River, it is possible that a braided channel or side channels existed when inundated at high flows. It is not likely that a single channel would have supported the broad stand of willow shrubs described by Nathan

Kimball. Willow expert Wayne Padgett lists sandbar willow (*Salix exigua*), yellow willow (*Salix lutea*), and caudate willow (*Salix lasiandra*) as probable species within the river corridor (Utah Division of Wildlife Resources 2003).

According to Wayne Martinson (personal communication with Brian Nicholson, SWCA, April 2010), C. W. Lockerbie's memoirs, which were first published by the *Utah Audubon News* in 1949, recall sandbars, banks, and a reclaimed channel covered by sandbar willows. Lockerbie further described larger willows possibly of the same species occupying an abandoned river terrace. While specifically characterizing the Jordan River at 1700 South, it is likely that similar species and conditions existed in the restoration area between 2200 North and the Salt Lake County line. In later years, Lockerbie recalled that the Jordan River was denuded of willows in many places, possibly the result of gathering by a local basket-making firm. The Utah Division of Wildlife Resources (UDWR) report supports this, citing a 1902 photo of the riverbank at 900 North with no vegetation, although a later photo from 1908 taken at 900 South does show a willow stand in the background (Utah Division of Wildlife Resources 2003). It is unclear to what extent and at what locations the Jordan River was dominated by large tree species (i.e., Fremont cottonwoods). Photos and pioneer journals record cottonwood groves at various sites along the Jordan River (e.g., Rose Park and 1700 South) (UDWR 2003). At present, a large cottonwood is found at the south end of the site adjacent to what appears to be the 1875 river channel. Tree cores age the individual to more than 78 years, but decay in the center representing more than half of the radius makes an exact age undeterminable.

By 1900, according to a Salt Lake City Engineer's Office map, the Jordan River was relocated to the east side of the proposed restoration area to roughly its present-day location (see Map 2). Also illustrated on this map is a sewage farm north of the restoration area and a series of lakes (including present-day Decker Lake) and sloughs to the southeast, connected by natural and artificial channels. A history of irrigated agriculture and livestock grazing is evident on the existing landscape within the restoration area. More recently, eyewitness accounts confirm that the site was inundated during the high-water years of the mid 1980s, and that phalaropes, a migratory shorebird, used the site for nesting during this period (personal conversation between Wayne Martinson and Brian Nicolson, SWCA, April 2010).

In 1885 the Surplus Canal was constructed at 2100 South to mitigate flood flows on the Jordan River before it passed through Salt Lake City. Much of the Jordan River flow has been diverted at 2100 South to the canal that runs along the western boundary of the Regional Athletic Complex. Flows in the section of the Jordan River adjacent to the Restoration Area are controlled by diverting water as necessary.

1.2 The Restoration Plan in a Local Context

The size and location of the RA in this plan is similar to what is shown in the Blueprint Jordan River (Envision Utah 2009). During that process, a large stakeholder group determined priorities for the restoration of degraded habitats along the Jordan River Corridor (which stretches from Utah Lake to the Great Salt Lake). This RA is 1.5 miles upstream of the Legacy Nature Preserve, and is one of the last tree-dominated riparian zones before the river enters the marshy lowlands of Great Salt Lake's Farmington Bay to the north.

One stated Blueprint goal is to enhance the connectivity of riparian habitat along the Jordan River through increased riparian vegetative cover and improved habitat quality. Other guiding principles in the Blueprint involve establishing buffers between the river and the built environment, restoration of riparian and in-stream habitats, and stormwater management. This plan will use Blueprint principles to design restoration strategies that will improve the ecology of the RA while balancing the needs for development, recreation, and public access (Envision Utah 2009).

This plan draws on previously successful restoration techniques used in mitigation areas, Salt Lake County restoration sites, and a variety of private and public lands along the Jordan River. Local experts from many conservation groups involved in Jordan River restoration have documented their techniques and shared their strategies with SWCA. In an ongoing effort, various groups continue to work to determine how restoration sites along the Jordan River will be managed into the future and how best to combat issues that are currently impacting the riparian ecosystem. Because the Jordan River passes through a variety of land ownership and local government boundaries, a wide variety of stakeholders must work together to ensure that restored areas are maintained.

1.3 Restoration Goal

In keeping with select Guiding Principles of Blueprint Jordan River, the restoration goal for this RA is to improve riparian and upland features and functions, including wildlife habitat and downstream water quality, while balancing the needs for development, recreation and public access in adjacent areas. This can be accomplished via the objectives outlined in the following section.

1.4 Objectives

The Jordan River, particularly the reach north of 2100 South (including the RA), is a highly altered system and its functions are constrained by channelization, urbanization, and flow modification. These conditions limit the scope of and the potential for ideal habitat restoration. Therefore, this restoration plan focuses on the following achievable objectives:

- Reduce weed cover in the RA via physical and chemical methods, and maintain the reduction over time.
- Establish structurally complex riparian, wetland, and upland habitats consisting of diverse, native plant species.
- Enhance existing habitat and increase the diversity and abundance of migratory bird species nesting in and migrating through the RA.
- Establish buffers and landscape features to physically and visually separate the natural and built environments on the west side of the Jordan River while providing education and access along the Jordan River Parkway on the east side of the river.

1.5 Ecological Foundations

1.5.1 Riparian Zones in the Intermountain West

This section describes the fundamental processes that occur in high-functioning riparian corridors in the Intermountain West. These processes will guide future data collection, the development of site-specific implementation, and success criteria. Although the discussion can be technical, these processes are important to consider because they illustrate a “virtual reference site” against which to assess the restoration constraints and potential of the RA site.

Riparian corridors are transitional areas between aquatic and terrestrial systems that generally compose a minor proportion of the western landscape. They include the natural extent of riparian vegetation from the stream or river edge to the point where upland habitat begins. Because they are associated with watercourses, they are vulnerable to severe alteration when water is diverted for other uses or streams are altered for flood control purposes (Montgomery 1996). By the very nature of this association with a stream and its water and flood regime, riparian corridors can support diverse plant communities. A stream's hydroperiod, which includes its flooding duration, intensity, and seasonality, is the ultimate determinant of riparian structure and function (Montgomery 1996). In addition to stream characteristics such as flow regime and sediment transport, the riparian corridor also has an effect on the stream as a source of sediments, large woody debris, and nutrients.

Riparian corridors are three-dimensional in nature. The vertical structure is provided by vegetation, the lateral profile is the exchange of nutrients and woody debris that results from seasonal inundation, and the longitudinal profile is the upstream and downstream extent that crosses multiple ecosystems and creates travel corridors for wildlife (Figure 1). Along the length of the Jordan River, the three-dimensional nature of the riparian corridor has been altered from its historical condition.

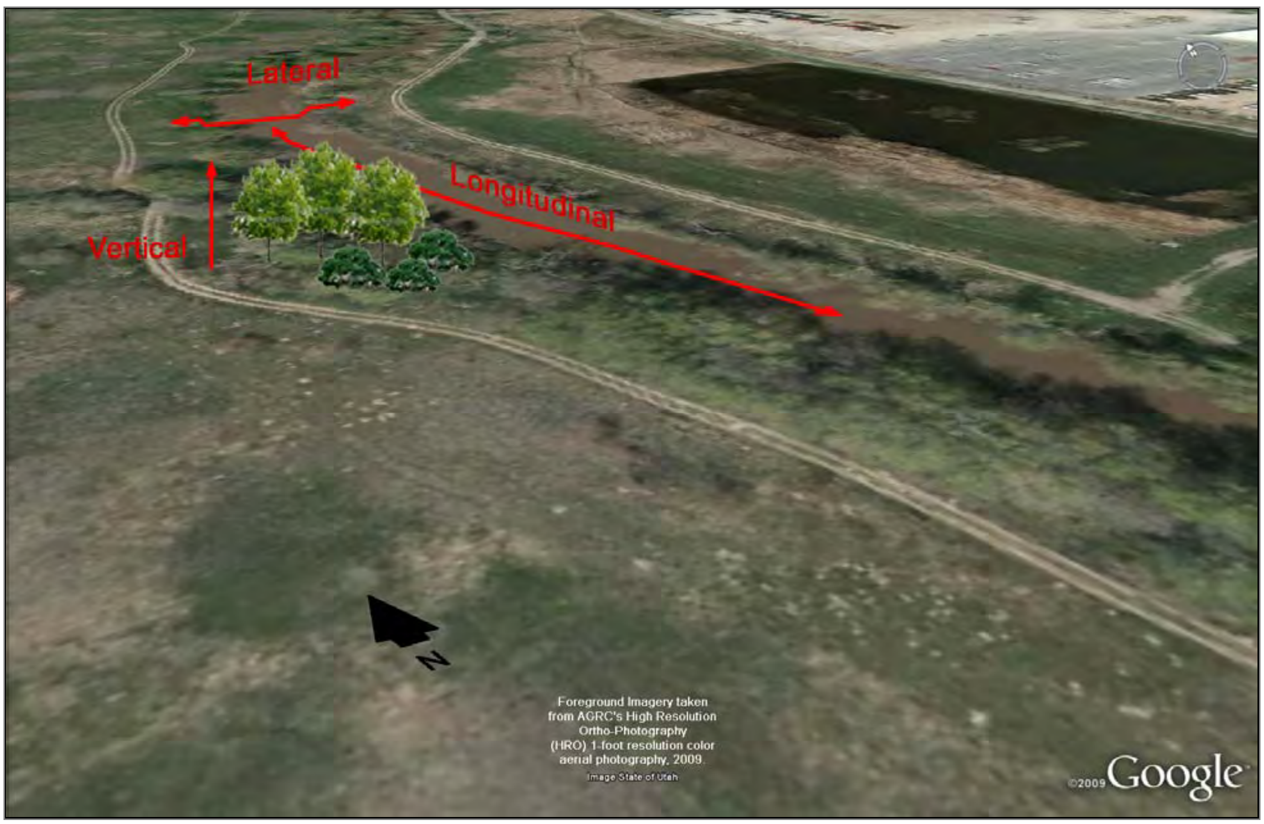


Figure 1.Three-dimensional riparian corridor.

Disturbance is a natural feature to all ecosystems including riparian corridors. Flooding and sedimentation are dominant sources of natural disturbance in riparian systems. In addition, fire, wind, and wildlife (i.e., beaver) are common forces that shape the riparian corridor and sometimes appear devastating, but in most cases result in rapid recovery. Human-made changes may have long-term adverse effects on riparian health. In particular, hydrologic modification, the building of dams across channels, the construction of levees, and the channelization of streams can adversely impact the three dimensions of riparian areas (Montgomery 1996). For example, water diversions from streams reduce base flows, limiting the extent and duration of flooding that constricts the width of the area capable of supporting riparian vegetation. This is currently the case in the RA.

Common disturbances to riparian corridors include vegetation clearing and conversion to other land uses. These alterations modify natural plant diversity and structure, lead to soil compaction and erosion, and decrease wildlife diversity. Non-native plant species also adversely impact riparian areas by outcompeting native plant species. This leads to decreased plant diversity and native habitat for birds and other wildlife species. In the case of the RA, there is an opportunity to help restore the three-dimensional structure to the riparian corridor, thereby improving plant species diversity and wildlife habitat.

1.5.2 Riparian Buffer Widths

"Riparian buffer" is a management term used to define the area adjacent to a river or stream that will be protected from development. The RA's riparian buffer will include riparian, wetland, and upland habitats. This area is usually larger than the natural riparian corridor. In the RA's case, the riparian buffer on the west side of the river varies from approximately 100 to 400 feet with an average width of approximately 240 feet. The east side buffer varies from approximately 25 to 340 feet with an average width of approximately 140 feet. These buffers are larger than the existing riparian corridor widths of approximately 5 to 40 feet. The exact size and shape of the RA will be determined upon completion of the Jordan River Parkway and Regional Athletic Complex planning processes.

In the United States, the median riparian buffer is 100 feet on each side of the stream. General guidance on riparian restoration has shown that 100 to 300 feet of stream buffer is required for a successful riparian restoration effort (FISCRWG 2001, ASLA 2009). The results of scientific studies on the minimum width of riparian buffers vary with each location and study design. A study in Missouri found that wider stream buffers (1,200–1,500 feet) have been shown to provide more songbird breeding habitat than narrow stream buffers (150–300 feet), but it is not clear whether the width, the diversity and complexity of the vegetation, or a combination of the two was the key factor affecting bird use in this study area (Peak and F.R. Thompson 2006). Another study showed that resident bird and short-distance migrant bird species diversity is mostly related to the density of riparian canopy cover in stream buffers ranging from 150 to 300 feet wide (Hennings and Edge 2003). These researchers concluded that increasing canopy cover and structural diversity is the most important land management action for native breeding bird conservation and restoration (Hennings and Edge 2003). Other studies have shown that greater plant species diversity and structural complexity is associated with a greater number of bird species. Structural complexity includes the number of layers (or strata) of vegetation (e.g., tree/canopy, shrub, herbaceous), as well as downed wood, litter, and microtopographic relief (FISCRWG 2001, Smith et al. 2008). Reptiles, amphibians, and small mammals all benefit from complex understory habitat structure (Queheillalt and Morrison 2006). Johnson and Buffler (2008) report that riparian buffer widths should range from 25 to 375 feet to improve water quality with variation due to factors such as slope, soil infiltration rate, and surface roughness, among other site attributes. To maximize wildlife habitat quality, recommended riparian buffers range from 30 feet to more than 600 feet depending on the wildlife species and riparian plant community type (Johnson and Buffler 2008).

Based on existing research, the entire length of the riparian buffer for the RA on the west side of the river is wide enough to support diverse wildlife, birds, and native plant species. It also meets either the gold (200 feet wide) or silver level (100 feet wide) environmental opportunity requirements outlined in the Blueprint Jordan River (Envision Utah 2009). The portions of the buffer on the east side of the Jordan River that are less than 50 feet wide (bronze level) are not ideal for a riparian buffer, but current land ownership constrains buffer expansion at this time.

1.5.3 Priority Bird Species

The RA contains upland, riparian, and wetland habitats that are generally low functioning due to high percentage of weed cover and a lack of human access restrictions. While these habitats currently serve as breeding, nesting, feeding, and resting habitat for a number of bird species, they can be improved to support additional bird species (Table 1, Appendix 1). Although there are many common bird species currently using the RA, some species that are present or that have the potential to use the area are less abundant, more unique, and/or less likely to have suitable habitat on neighboring portions of the landscape. The ten species listed in Table 1 can be considered priority species for habitat restoration and management. All of these species are migrants and nine of the ten are songbirds. Our goal is to provide improved habitat for common as well as less-abundant species. The focus on specific bird species ensures that restoration efforts will enhance habitat components suitable to species on the list (e.g., plant species composition or vegetation structure), as well as create habitat suitable for species of the same family. However, the list will remain amendable, and species may be added to or dropped from the list depending on future management goals and results. Species of other taxa (e.g., mammals, amphibians, and macroinvertebrates) may also be given future consideration, although more baseline data must be collected on these groups. A comprehensive list of bird species observed in the RA and those with the potential to occur is provided in Appendix 1.

Table 1. Priority Bird Species

Name	Family Name	Habitat	Presence in RA
Belted Kingfisher *Ceryle alcyon*	Kingfisher	Variety of aquatic habitats (streams, rivers, ponds); needs a nearly vertical earthen exposure for digging nesting burrows	Potential nester
Black-headed Grosbeak *Pheucticus melanocephalus*	Grosbeak (Songbird)	Wooded, brushy habitat. Uses upper level of trees	Potential nester
Bullock's Oriole *Icterus bullockii*	Oriole (Songbird)	Deciduous trees in or near openings. Forage in low brush and trees	Potential nester
Common Yellowthroat *Geothlypis trichas*	Wood-warbler (Songbird)	brushy, and marshy habitats, nearly always in wet areas	Potential nester
Lazuli Bunting *Passerina amoena*	Bunting (Songbird)	Brushy habitats, especially along streams in arid regions	Potential nester
Red-winged Blackbird *Agelaius phoeniceus*	Blackbird (Songbird)	Nests and roosts in wet, marshy, or brushy habitat, can be a small area. Forages in open fields	Potential nester
Song Sparrow *Melospiza melodia*	Sparrow (Songbird)	Brushy areas near water	Observed
Violet-green Swallow *Tachycineta thalassina*	Swallow (Songbird)	Open deciduous, coniferous, and mixed woodlands	Potential nester
Yellow-breasted Chat *Icteria virens*	Wood-warbler (Songbird)	Dense tangled brushy patches and hedgerows in open sunny areas	Potential nester
Yellow Warbler *Dendroica petechia*	Wood-warbler (Songbird)	Wet brushy areas, willow thickets	Observed

2.0 Existing Conditions

2.1 Vegetation

The riparian forest complex currently occupies 6.9 acres of the RA and is dominated by non-native and invasive trees including Siberian elm (*Ulmus pumila*), black locust (*Robinia pseudoacacia*), American elm (*Ulmus americana*), and Russian olive (*Elaeagnus angustifolia*) (Figure 2). The dominant understory species are hoary cress (*Cardaria draba*) and poison hemlock (*Conium maculatum*). Scattered native trees include Fremont cottonwood (*Populus fremontii*), peach leaf willow (*Salix amygdaloides*), and box elder (*Acer negundo*). The existing distribution of all habitat types is shown on Map 3.

The existing 20.7 acres of upland grassland habitat is dominated by cheatgrass (*Bromus tectorum*) and intermediate wheatgrass (*Thinopyrum intermedium*). There is an existing upland shrubland restoration area (6.7 acres) dominated by golden currant (*Ribes aureum*) and black hawthorn (*Crataegus douglasii*).The understory of the shrub area is dominated by weedy grasses and forbs.

There are currently 4.7 acres of off-channel wetlands and 1.7 acres of emergent bench wetlands in the RA. These habitat types are dominated by the invasive species common reed (*Phragmites australis*) and reed canarygrass (*Phalaris arundinacea*).

In 2003, UDWR biologists estimated that less than half the vegetative cover in the RA and adjacent Regional Athletic Complex site was made up of native plant species (Utah Division of Wildlife Resources 2003). Several non-native species in the RA are highly invasive and considered noxious weeds by the State of Utah.

Figure 2. Weedy trees and forbs in the RA riparian corridor.

2.2 Wildlife

The most recent wildlife surveys in the RA and adjacent Regional Athletic Complex were completed in 2003 by the UDWR; 41 bird species, one amphibian, and 10 small mammals where recorded (see Appendix 1 and Map 1). Two bird species and one mammal species that were observed are non-native. There were no federally listed threatened or endangered species and no state wildlife species of concern observed during the UDWR surveys (Utah Division of Wildlife Resources 2003).

2.3 Human Activity

Disturbances in the RA include hikers, transients, model airplanes, noise from vehicle traffic on Interstate 215 and Redwood Road, the neighboring OHV park, stormwater pollution, and litter. The RA and adjacent Athletic Complex are bordered by residential development to the south, the motorized vehicle park (OHVs) to the north, industrial development to the east, and I-215 to the west. Historically, the RA has been used for irrigated agriculture and livestock grazing. The river's east side is bounded by a berm that is the future location of the Jordan River Parkway. The Jordan River through the RA appears to be channelized. This hydrological modification has likely contributed to river degradation, a process by which the bed of the channel is lowered relative to the surrounding landscape.

2.4 Soils

Soils in the RA are typical of offshore deposits of ancient Lake Bonneville that have been reworked by the Jordan River's alluvial processes in recent geologic periods. The Salt Lake County soil survey was used to identify the existing soils on the property (Woodward et al. 1974). Lewiston is the site's primary soil series. Data gathered during a site geotechnical analysis confirmed the presence of loam or clay loam soil textures characteristic of this series. Soil layers consist of lean clay with sand, sandy lean clay, clayey sand, and poorly graded sand with interbeded clay seams. For a more complete description of soils at the site and their geo-technical characteristics, refer to the report prepared by Professional Service Industries, Inc. for MGB+A The Grassli Group (Professional Service Industries 2006).

In 2006, Professional Service Industries, Inc. conducted top soil sampling at the site (Table 2). In general, the site has pH and electrical conductivity levels acceptable to support a range of desirable or native plants. However, nitrate-nitrogen and organic matter are low (Professional Service Industries 2006).

Table 2. Topsoil Properties

Site Location	% Sand	% Silt	% Clay	Texture	pH	EC (Mmhos/cm)	% OM	NO_3-N (ppm)
South (B-3)	46	33	21	Loam	7.71	0.82	3.66	6.14
Central (B-6)	28	39	33	Clay Loam	6.90	1.44	3.11	18.91
North (B-15)	22	39	39	Clay Loam	7.98	0.24	4.59	7.98
Acceptable Levels	–	–	–		5.5- 7.7	<2.0	>2.0	>48

Existing soil conditions necessitate the addition of topsoil to augment structure, nutrients, and mycorrhizae before planting can occur. Because of the potential for incidental augmentation of weed growth, artificial fertilizers (even organic ones) will not be used. The non-uniform layering of sand and clay in the soil profile warrants more detailed soil sampling in the RA prior to implementation.

2.5 Water Quality

The Utah Division of Water Quality (UDWQ) has listed the Jordan River on the 303d list for impaired waters. Routine water-quality monitoring data collected by the UDWQ at stations on the Jordan River indicate that levels of dissolved oxygen, total dissolved solids, *Escherichia coli* (*E. coli*), and water temperature are in violation of the designated beneficial use standards assigned to several Jordan River segments. Waterbodies in Utah are grouped into classes according to beneficial use as a way to establish standards for water quality. For example a water body that is used for recreation has a different standard or limit for the level of *E. coli* than one that is used for agricultural or drinking water. In the case of the Jordan River reach adjacent to the proposed Athletic Complex, its beneficial uses include secondary contact recreation (e.g. wading, hunting and fishing where there is a low likelihood of ingestion or low degree of bodily contact) and fishing for warm water fish species. The Jordan River does not currently support secondary contact recreation because of high levels of *E. coli* and is in only partial support of warm water fishing due to low levels of dissolved oxygen (Cirrus Ecological Solutions 2007).

In addition to chemical water-quality concerns, the Jordan River is a significant source of invasive plants, the seeds of which are carried down the river from upstream weed populations. These physical and chemical components will likely limit the Jordan River's utility as a restoration water source. For example, applying unfiltered Jordan River water to the RA would introduce invasive weed species which would be difficult and costly to control, especially on bare or disturbed ground.

2.6 Hydrology

A water master at the outflow of Utah Lake controls the Jordan River's hydrology. The volume and timing of water in the system is a function of the storage capacity of Utah Lake and the irrigation needs of downstream users. Inputs from tributaries, stormwater, and agricultural return flows also account for portions of the river hydrograph (Figure 3). Upstream of the RA, near where the river is crossed by 2100 South, much of the water in the Jordan River is diverted to the Surplus Canal, and only a portion passes through the RA to serve water users and maintain beneficial uses such as warm water fisheries.

Salt Lake County Flood Control maintains a flow gauge at 500 North on the Jordan River. It is the closest gauge to the RA with no significant diversions or inputs between the two points. Data from Salt Lake County for portions of the 2008, 2009, and 2010 water years (October 1 to September 30) show a variation in average daily flow, from approximately 70 cubic feet per second (cfs) to 450 cfs (Figure 3). Changes in stage or depth at the 500 North gauge vary between 1.3 feet at low water and 5.6 feet at high water.

Using the same data set, the flow duration graph (Figure 4) illustrates volume during the 2009 water year in terms of percentage. During 2009, 50% of flows were below 217 cfs. Such data are useful in combination with site-specific cross-sections when considering wetland creation or bank modification because they allow the practitioner to estimate the amount of time a site or specific elevation will be inundated. For example, some habitat types benefit from intermittent flooding while others benefit from more sustained or deeper inundation.

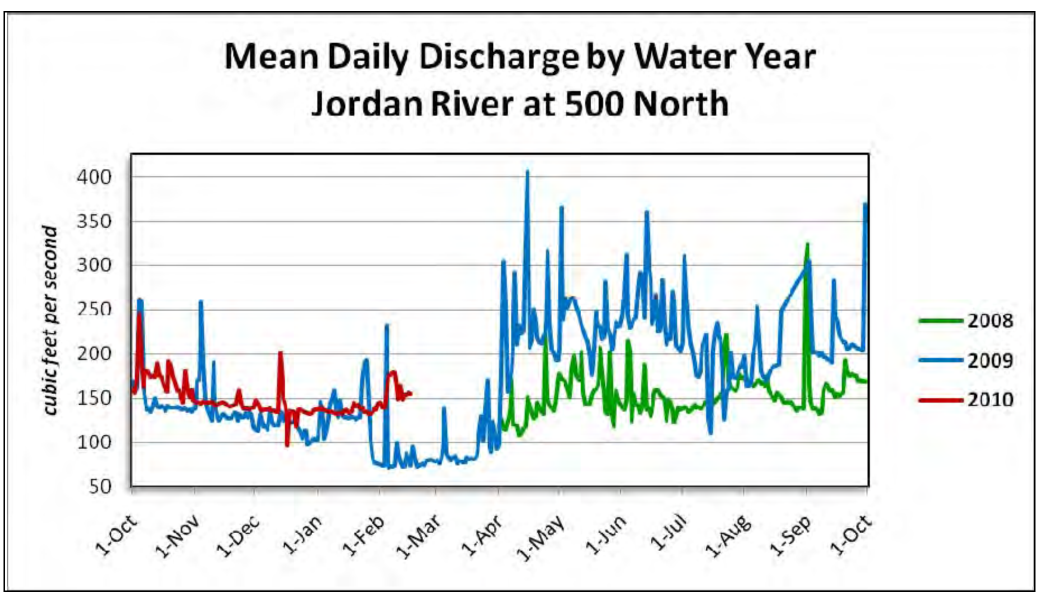


Figure 3. Annual hydrograph for the Jordan River at 500 North, from 2008 to 2010.

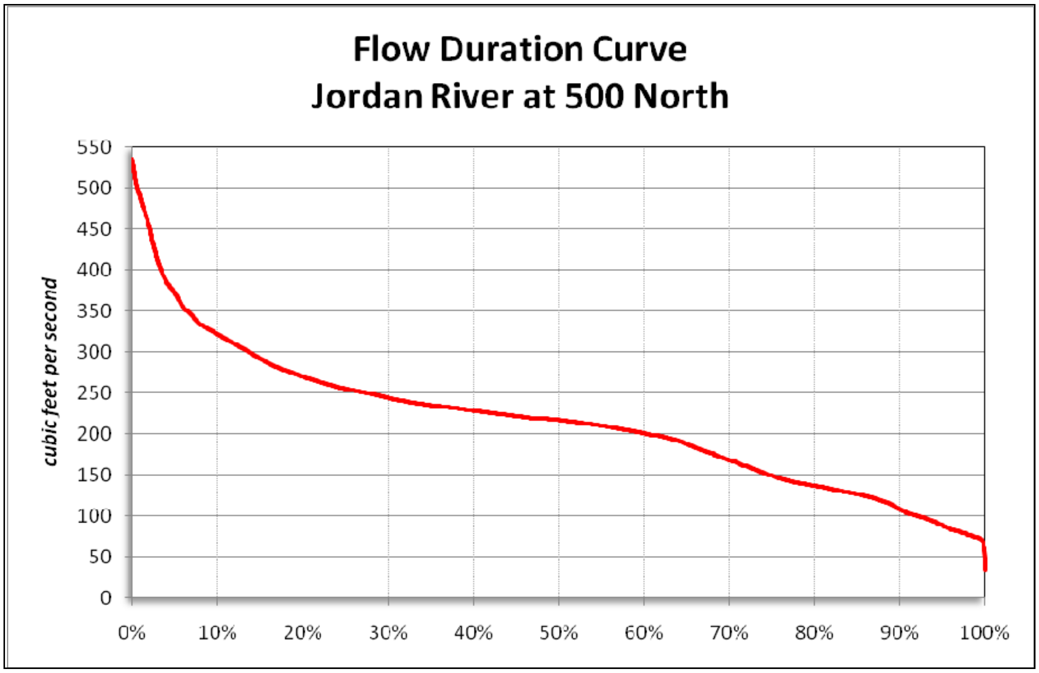


Figure 4. Average daily Jordan River flow duration curve.

Groundwater resources are an important component of site hydrology when considering restoration activities. Shallow groundwater occurs at depths from approximately 2 to 8 feet below existing site grades in the RA (Professional Service Industries 2006). Typically in riparian zones the groundwater is closer to the surface of the stream or river. But in the case of the RA, proximity to the Jordan River does not appear to correlate with depth to free water. Historic land use such as agriculture, ditch maintenance, and the deposition of dredge material adjacent to the Jordan River has likely altered existing soil surface elevations. Using groundwater to create and sustain wetland habitat may require considerable excavation and will only be done in areas where groundwater is relatively close to the surface.

3.0 Restoration Design

This section outlines strategies for improving the existing conditions and ecological function in the RA. Conceptual drawings and restoration strategies are provided for each of the six habitat types that will be created in the RA (see Map 4). Map 4 also provides the future locations and extents of each habitat type in the RA. The habitat types, locations, and sizes were determined in the field by SWCA ecologists and restoration specialists in May 2010. The implementation of the restoration design presented in Map 4 is contingent on future funding. Examples of successful restoration projects on the Jordan River are also provided. The techniques for restoring the RA include public involvement, creation of physical buffers, weed management, excavation, planting, and irrigation, and are all described in this section.

3.1 Restoration by Habitat Type

Restoration strategies vary by habitat type. The following sections provide information on habitat restoration/creation for six habitat types: off-channel wetlands, graminoid slope wetlands, emergent bench wetlands, riparian forest complex, upland grasslands, and upland shrublands. Table 3 provides the approximate costs of restoration per acre for each habitat type. Appendix 2 contains a more detailed list of restoration costs and Appendix 3 provides a list of plant species to be used for restoration.

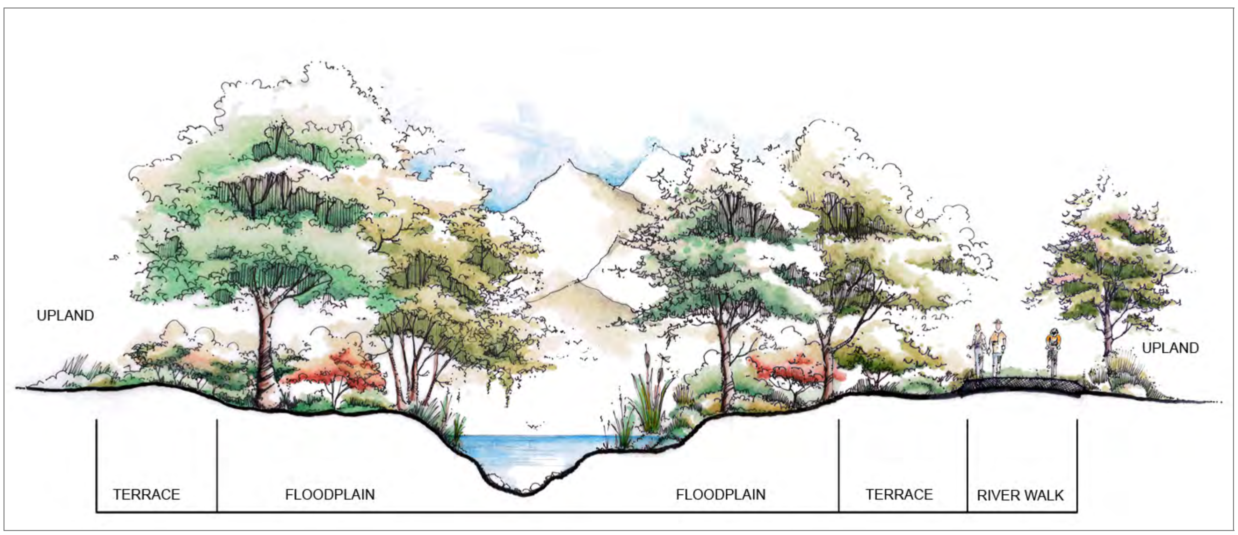


Figure 5. Cross section of riparian and upland restoration in the Jordan River riparian buffer.

3.1.1 Off-channel Wetlands

To minimize the potential for the introduction of invasive species to the RA via the Jordan River, the existing low berm between the wetland creation/enhancement areas and river can be augmented to prevent inundation of the off-channel wetlands. Wetland hydrology can be provided by accessing groundwater in these areas. Creating off-channel wetlands will increase the RA's overall habitat diversity and improve wetland habitat quality while meeting the requirements of the Clean Water Act Section 404 permit issued by the U.S. Army Corps of Engineers. The locations of the 3.0 acres of mitigation wetlands that will be created as well as the existing 5.0 acres of off-channel wetlands are shown on Map 4. The existing off-channel wetlands will be treated for weeds and revegetated with native species (Map 3). Wetland species plugs and a seed mix can be used to revegetate this habitat type following any necessary weed treatment. This treatment involves excavation and will not be considered in areas where depth to ground water makes accessing free water practicably prohibitive.

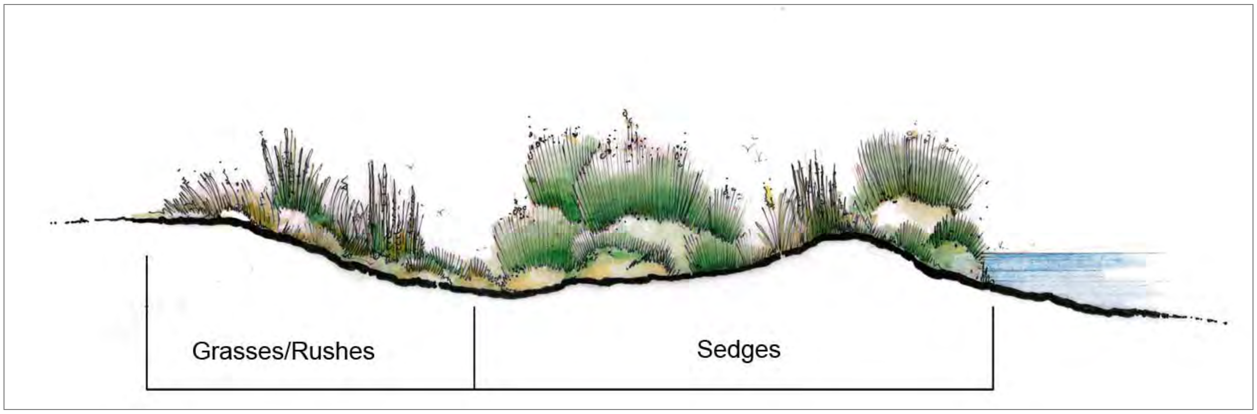


Figure 6. Cross section of off-channel wetlands restoration in the Jordan River riparian buffer.

3.1.2 Graminoid Slope Wetlands

The band can be laid back in areas where vertical or cut banks create unstable conditions or contribute sediment to the river through active sloughing, or areas where upland vegetation communities directly abut the Jordan River. This allows a more gradual transition from river to upland, and provides a location for the establishment of a diverse community of wetland and riparian plants along the banks of the river. Wetland species plugs and a seed mix can be used to revegetate this habitat type following any necessary weed treatment. This treatment involves excavation and slope erosion control. It is not suitable for areas with existing low bank angles, adequate desirable vegetation cover, or dense tree root systems. Future conditions in the RA will include the creation of 0.7 acres of graminoid slope wetlands as shown on Map 4. There are no wetlands of this type currently in the RA.

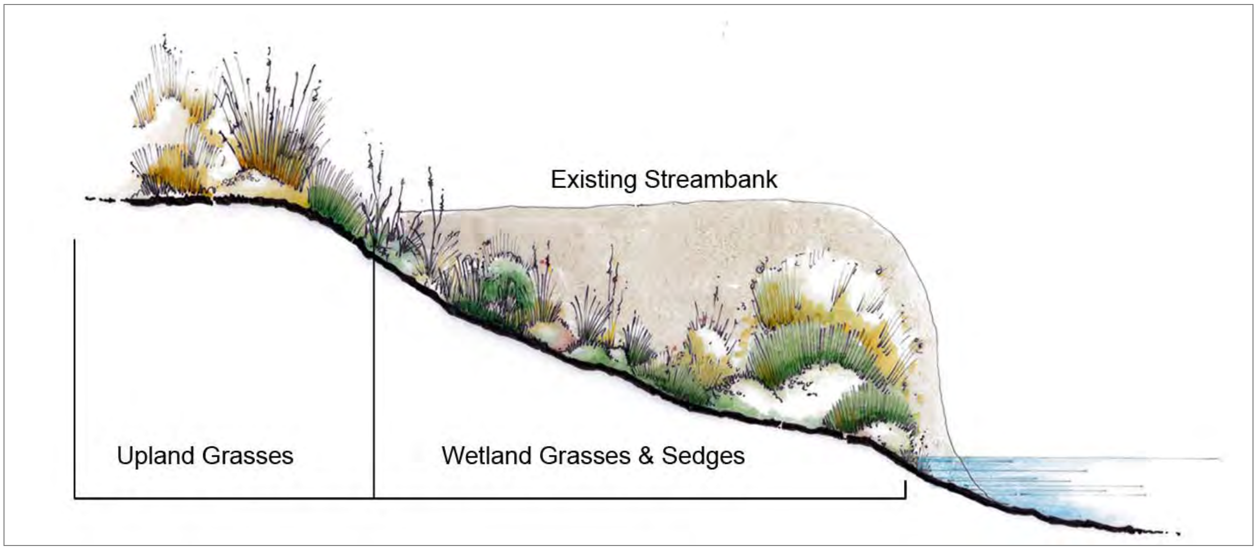


Figure 7. Cross section of graminoid slope wetlands creation in the Jordan River riparian buffer.

3.1.3 Emergent Bench Wetlands

Emergent benches are areas along the river dominated by wetland plant species. Existing emergent benches in the RA can be treated for weeds, after which, wetland species plugs and a seed mix can be used to revegetate the benches. On the river's west side, additional emergent benches can be excavated and planted with wetland vegetation to create a diverse native habitat in place of existing non-vegetated streambanks. In some areas, a back channel will be created between the emergent bench and the streambank. This will create small islands in the river. This treatment requires adequate flow and stage data so that the elevation of these emergent benches can be inundated under the Jordan River's managed flow regime. Future conditions in the RA will include the creation of an additional 0.3 acres of emergent bench wetlands as shown on Map 4. Restoration on the existing 1.7 acres of this wetland type in the RA will include weed treatment and revegetation with native species.

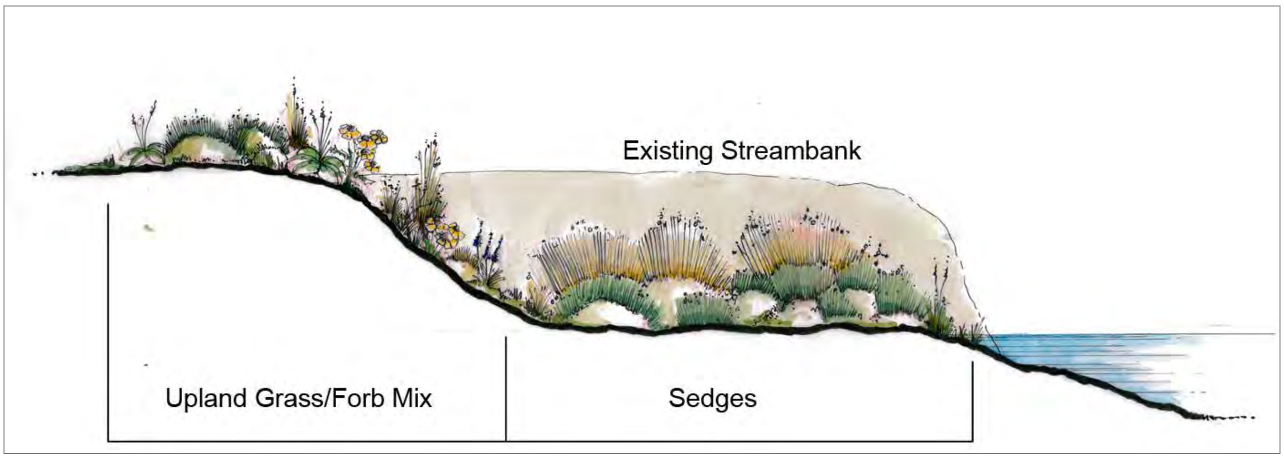


Figure 8. Cross section of emergent bench wetlands creation in the Jordan River riparian buffer.

3.1.4 Riparian Forest Complex

Riparian forest structure in the RA is currently dominated by non-native tree species and weedy forbs. For this habitat type, restoration treatments can be designed to enhance forest structure through thinning and replanting. Because riparian trees and shrubs, native or not, provide wildlife habitat and bank stabilization, non-native tree and shrub species can be replaced with native species over a period of 10 to 20 years. Monocultures of the noxious weed species, Russian olive, will be removed in the first few years of the restoration. This will minimize impacts to habitat and existing wildlife in the riparian corridor. The goal is to remove all non-native grass and forb species by chemical and/or physical methods, and replace them with native and desirable species. This includes removal/treatment of any non-native tree seedlings. This method provides an opportunity for newly planted native trees and shrubs to establish prior to the removal of a significant riparian tree and shrub cover. Approximately 5 to 10 non-native trees will be girdled. This will create snags, which provide excellent roosting habitat for some species. This treatment may involve excavation to access groundwater. Restoration of this habitat type will result in the creation of a structurally complex, species rich habitat. Future conditions in the RA will include the creation and/or improvement of 5.9 acres of riparian forest complex in the

RA (Map 4). There are currently 6.9 acres of this habitat type in the RA (Map 3). The reason for the decrease in acres of this habitat type is the removal of a large stand of invasive Russian olive in the southern most section of the RA on the west side of the river. These invasive trees will be removed and replaced with upland shrubs and grasses.

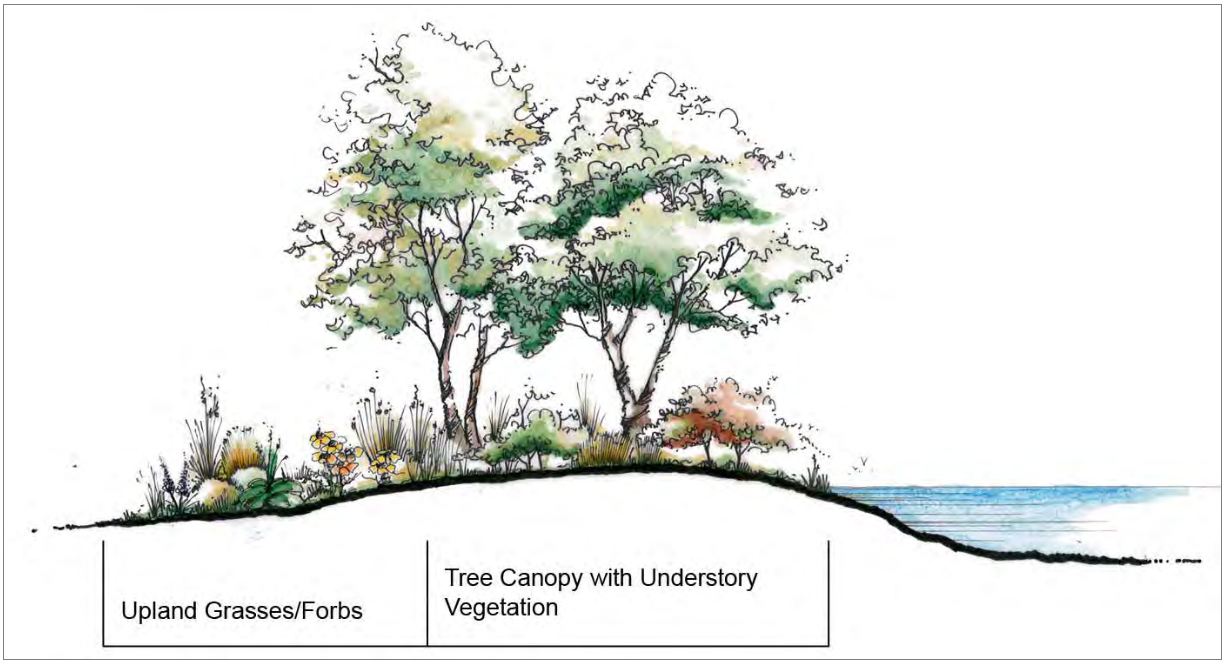


Figure 9. Cross section of riparian forest complex restoration in the Jordan River riparian buffer.

3.1.5 Upland Grasslands

Uplands in the RA are currently dominated by noxious and non-native grasses and forbs. Restoration treatment will involve the removal of the non-native grass and forb species by chemical and/or physical methods, followed by planting and seeding with native and desirable grass and forb species to create a healthy native habitat. This treatment will not require excavation. Future conditions in the RA will include the creation/ improvement of 19.1 acres of upland grasslands as shown on Map 4. There are currently 20.7 acres of this habitat type in the RA. The reduction in acres of this habitat type in the RA is a result of the conversion of some areas to wetlands (Maps 3 and 4).

Figure 10. Cross section of upland grasslands restoration in the Jordan River riparian buffer.

3.1.6 Upland Shrublands

A small portion of the existing upland grassland in the RA can be converted to upland shrubland. All of the existing upland shrubland in the RA will be improved; the planted golden currant and black hawthorn will be protected. Restoration treatment will involve the removal of the non-native grass and forb species by chemical and/or physical methods, followed by planting and seeding with native and desirable grass, forb, and shrub species to create a healthy native habitat. Approximately 30% shrub cover is desired. This treatment will not require excavation. Future conditions in the RA will include the creation of an additional 0.7 acres of upland shrublands as shown on Map 4. There are currently 6.7 acres of this habitat type in the RA that will be treated for weeds and revegetated with native understory species (Map 3).

Figure 11. Cross section of upland shrublands restoration in the Jordan River riparian buffer.

Table 3 provides the price range, by habitat type, for the restoration of one acre of land. The price ranges provided include the variation in cost of plants and labor as well as the difference in cost between restoration including and excluding excavation. These prices do not include the costs of long-term monitoring and maintenance. Table 4 provides the total cost of restoration, by habitat type, for the entire restoration area as shown on Map 4.

Table 3. Initial Restoration Costs per for Each Habitat Type

Habitat Type	Treatments	Approximate Price Range per acre*
Off-channel Wetlands	Excavation, weed treatment, wetland plugs, and seed mix and irrigation	$20,000–$35,000
Graminoid Slope Wetlands	Excavation, weed treatment, wetland plugs, and seed mix	$30,000–$50,000
Emergent Bench	Excavation, weed treatment, wetland plugs, and seed mix	$30,000–$50,000
Riparian Forest Complex	Weed treatment, container trees and shrubs, pole plantings, seed mix, irrigation	$20,000–$40,000
Upland Grasslands	Seeding grasses and forbs, irrigation	$5,000–$8,000
Upland Shrublands	Seeding grasses and forbs, planting 800 shrubs (high end), irrigation	$8,000–15,000

* These costs do not include maintenance or monitoring.

Table 4. Initial Restoration Costs by Habitat Type for the Restoration Area

Habitat Type	Total Acres Following Restoration	Approximate Price Range
Off-channel Wetlands	8.0	$160,000-$280,000
Graminoid Slope Wetlands	0.7	$21,000-$35,000
Emergent Bench	2.0	$60,000-$100,000
Riparian Forest Complex	5.9	$118,000-$236,000
Upland Grasslands	19.1	$95,500-$152,800
Upland Shrublands	7.4	$59,200-$111,000
Total Restoration Area	**44.3**	**$513,700-$914,800**

* These costs do not include maintenance or monitoring.

3.2 Examples of Jordan River Restoration Success

Although restoration in an urban riparian system is a challenge, there are many examples of successful restoration on the Jordan River. Photos of two successful restoration projects are provided below (Figures 12 through 15).

Figure 12. Midvale site riparian forest complex restoration on the Jordan River, 2007.

Figure 13. Midvale site riparian forest complex restoration on the Jordan River, 2009.

Figure 14. Legacy Nature Preserve graminoid slope wetland restoration on the Jordan River, 2009.

Figure 15. Legacy Nature Preserve graminoid slope wetland restoration on the Jordan River, 2009.

3.3 Public Involvement

Natural areas such as the RA can benefit from "adoptive" programs in which community members participate in various aspects of implementation, monitoring and maintenance of a site. There are many opportunities for local conservation organizations, schools, and adjacent residents to support the RA. This type of public involvement will help to create a feeling of ownership for the RA as well as providing an opportunity for experiential learning. Specific tasks that are well suited to volunteers include plant installation, weed control, trash removal, and educational programming. Training and adequate supervision will be necessary for most activities given the skill levels and experience of the volunteers.

3.4 Physical Buffers

Physical distance provides a buffering effect between a natural area and a source of disturbance. To create a greater buffering effect, an approximately 8 foot tall buffer will be installed along the edge of the RA. This buffer will consist of a fence situated on top of a berm. Native shrubs and trees will be planted along the fence line to create a vegetative screen visually separating the RA from the Athletic Complex. For example construction of a berm in combination with a fence and dense vegetation can disrupt the sightlines of nesting birds, provide cover for mammals, dictate travel corridors for small mammals, reptiles, and amphibians and reduce the overall effects of anthropogenic presence on the species in the RA.

3.5 Weed Management

This plan emphasizes an integrated and adaptive weed management approach for treating weeds in the RA. It considers present conditions and emphasizes a holistic restoration of native vegetation via cultural, mechanical, biological, and chemical weed management strategies. It incorporates a commitment to reduce and contain weedy plant infestations, prevent unnecessary environmental disturbance, and restore and maintain desirable ecosystem functions.

3.5.1 Utah Weed Regulatory Guidance

Laws and regulations concerning noxious weeds exist at both the federal and state level, and numerous federal and state agencies maintain lists of noxious weed species that must be controlled. Generally, federal weed laws and regulations are geared toward preventing unwanted plants from entering the United States, whereas state laws and regulations are aimed more at the control and removal of noxious weeds (Environmental Protection Agency 2006).

In recognition of the ecological and economic impacts of weeds, the State of Utah adopted the Utah Noxious Weed Act (Utah Code, R68-9), which was recently updated on December 1, 2009. The act requires landowners to control state-listed noxious weed species on their property if these species are likely to encroach on neighboring lands. The act stipulates that each county and municipality in Utah must adopt a noxious weed management plan for its jurisdiction and appoint an advisory board to develop the weed management plans and identify any plant species in the area that it considers noxious weeds. If landowners and managers fail to control weeds on their property, the county or municipality may legally enter the property, control weeds, and charge the landowner for the cost of the work.

The State of Utah has identified 29 species as noxious weeds and categorized them into three classes.

- Class A: Early detection rapid response (EDRR) – These weeds are not native to Utah and pose a serious threat. These species are considered a very high priority for removal.
- Class B: Control – These are weeds not native to Utah that pose a threat to the state. They are considered a high priority for control.
- Class C: Containment – Class C weeds are not native to Utah, and pose a threat to the agricultural industry and agricultural products.

Table 4 lists those species identified in the riparian buffer during a preliminary assessment that was conducted during a site visit on February 1, 2010, and provides their regulatory classifications. A complete survey is necessary during the growing season (April–May) to accurately determine all weed species present on the project area. Table 4 also lists the invasive and weedy plant species identified in the riparian buffer that are not included in the state's noxious weed list but could also pose a threat to ecosystem function and the health of the Jordan River riparian corridor if not treated and controlled.

Table 4. Regional Athletic Complex Preliminary Weed List

Common Name	Scientific Name	Classification
Hoary cress	*Cardaria draba*	Utah Noxious Class B
Russian knapweed	*Centaurea repens*	Utah Noxious Class B
Poison hemlock	*Conium maculatum*	Utah Noxious Class B

Table 4. Regional Athletic Complex Preliminary Weed List

Common Name	Scientific Name	Classification
Dalmation toadflax	*Linaria dalmatica*	Utah Noxious Class B
Scotch thistle	*Onopordium acanthium*	Utah Noxious Class B
Saltcedar	*Tamarix ramosissima*	Utah Noxious Class C
Cheatgrass	*Bromus tectorum*	Invasive
Fuller's teasel	*Dipsacus fullonum*	Invasive
Russian olive	*Elaeagnus angustifolia*	Invasive
Common reed	*Phragmites australis*	Invasive
Siberian elm	*Ulmus pumila*	Invasive

3.5.2 Managing Plant Community Composition

One approach to adaptive or ecologically based invasive plant management is to create weed-resistant plant communities using desirable—and preferably native—plant species (Sheley and Mangold 2005). The factors that drive native plant communities toward weedy infestations include disturbance, colonization, and species performance. Changing the current plant community dominated by weeds to a plant community dominated by a variety of native species involves changing and controlling these same factors. It is important to select native revegetation species that will successfully compete with weedy species.

3.5.3 Cooperative Weed Management Areas

Cooperative weed management areas (CWMAs) are local organizations consisting of land managers and landowners that work together using their expertise and resources to manage weeds in a defined area. CWMAs can be an effective resource in facilitating the prevention, detection, and suppression of noxious and invasive weeds. Coordinated mechanical, chemical, and biological control over large areas by multiple landowners has proven successful for a variety of weed species.

Many cooperative partnerships have been created to control weeds throughout the region. Although some of these are documented under Memorandums of Understanding, most have been created through the establishment of a cooperative weed management area participative agreement. Most of these efforts have many partners, including state agencies, county governments, universities, extension offices, tribes, specific interest organizations, and private parties. The RA falls within the geographic boundaries of both the Bonneville CWMA and the South Shore CWMA. Both organizations have adopted the Jordan River and are actively applying for grants and funding to treat weeds and increase educational awareness.

3.5.4 Weed Mapping

The primary objective of surveying and mapping weeds is to accurately delineate infestations, and identify land threatened by noxious and invasive weed encroachment. Mapping is done not only to document baseline conditions, but to develop weed management goals and objectives, increase public awareness, and evaluate weed management progress as it relates to noxious weed spread rates and patterns.

3.5.5 Ranking Noxious and Invasive Weed Species

It is impossible for the vast majority of landowners and land managers to control every weed that occurs on their property or management area. Therefore it makes sense to focus control efforts on those weed species that have the greatest impact on the resource base, and those which become more difficult to control if action is delayed. Weed management priorities can be established by determining which are 1) the priority weed species, and 2) the priority weed infestations, in light of the established weed management objectives.

3.5.6 Priority Weed Species

Some areas may contain one or two weed species while others may contain multiple species. In some cases, it may be feasible to control all noxious weeds with a single treatment. At the opposite extreme, the presence of numerous noxious weed species is likely to necessitate multiple treatments. These weeds will not be controlled in the short term. In cases where a complete control program would require more time and money than is available or prudent to spend, managers must decide which weed species are most important to control.

3.5.7 Control Methods

3.5.7.1 Goats

The controlled use of goats as a weed control agent has numerous benefits: reducing chemical use, minimizing soil disturbance, building up soil nutrients, and providing an accessible and unique education opportunity for the public regarding noxious weed management. Goats prefer weeds over grasses for forage. Their narrow, triangular mouths enable them to pick, nibble, and chew very fast, and are particularly suited to thorough mastication of most seeds, rendering them non-viable (Lamming 2001). Exposure of seeds to a goat's gastric enzymes completes the breakdown of seed structure and toxins. Seeds of desirable species can be broadcast during the goats' grazing periods. This helps incorporate seeds into the surface soil (Lamming 2001) because the goats' small hooves will gently manipulate soil without causing extensive damage.

Goats eat most poisonous plants that sheep and cattle are unable to tolerate. They have an array of digestive enzymes and saliva that detoxifies specific compounds, although there are some weed species (such as hoary cress monoculture) that goats are unable to digest without iodine or other additional dietary supplements (McInnis et al. 1993, Lamming 2001). Grazing selectivity by goats may include the palatability of the weed species, which is often related to age of the plant, as well as goat age and gender. Goats effectively control common reed, musk thistle, Russian thistle, elm trees, Russian olive, field bindweed, and leafy spurge (Lamming 2001).

Timing is critical to effectively treat weedy species using goats. Flower heads are removed first, followed by leaves, leaving the plant with reduced photosynthetic tissue with which to regenerate (Lamming 2001). Many plants rely on root reserves to regenerate after being grazed, thereby depleting their stored carbohydrates. It is in this vulnerable state that goats would be brought in to graze a second time. Repeated application of any control mechanism is necessary to gain control of an invasive plant issue, and grazing (i.e., weed suppression) is no different. It must be repeated within a season and for several consecutive seasons to achieve control. Goats are a good substitute for chemical control near the riverbank in the RA. The goats will be fenced at an appropriate distance from the edge of the Jordan River to prevent fecal matter from entering the water. Water quality analysis is necessary to determine the impact of goat grazing near the Jordan River.

3.5.7.2 Plant Pathogens and Insects

The use of herbivores and pathogens found in a given weed's native range can be an effective way to control that weed species. Pathogens that cause disease in specific plants include bacteria, fungi, nematodes, protozoa, and viruses. Some organisms are host-specific, whereas others are capable of infecting several species (Coombs et al. 2004).

Insects have been successfully used as biological control agents throughout the United States. They can attack the plant in both the larval and adult stages, damaging the leaves, stems, flowers, and root systems. Releasing new insects involves the use of either a field insectary or a field nursery site. Many factors influence the survival and success of released agents on noxious weeds, among the most important being how many agents are released and how often they are released. Larger releases are more successful because they reduce the risks of genetic effects and accommodate population shifts in highly variable environments.

Federal regulatory parameters are set in place to ensure the weed's natural enemy would not itself become a threat to the ecosystem.

3.5.7.3 Chemical Controls

Numerous herbicides are useful in the reduction and eradication of noxious weeds. Because portions of property consist of wetlands and riverbank, it is necessary to assess the persistence of the chemicals in these environments and their effects on non-target plants and animals. Chemical herbicides may persist in upland and drier areas due to the lack of water and subsequent hydrolysis (breakdown) of the herbicide. Herbicides can be categorized according to how they move through a plant: downwardly mobile, upwardly mobile, and contact. Choosing the correct herbicide for the target species is important to avoid damaging desirable species, ensuring effective control of the weed species, and avoiding impacts to wildlife and the environment. Table 5 summarizes commonly used herbicides and their effectiveness on target species with potential to occur in the RA. Ratings are presented if available (Colorado State University 2000, Dewey et al. 2006).

Table 5. Herbicides for Noxious and Invasive Weed Species Control

Common Name	Scientific Name	Aminopyralid	Glyphosate	Imazapic	Imazapyr	Chlorsulfuron
Russian knapweed	(*Acroptilon repens*)	E	G, P	G	X	F
Jointed goatgrass	(*Aegilops cylindrica*)	P	E, G	X	X	X
Cheatgrass	(*Bromus tectorum*)	P	E, G	E	X	X
Hoary cress	(*Cardaria draba*)	F	G, F	G	X	E
Musk thistle	(*Carduus nutans*)	E	E	G	X	G
Yellow starthistle	(*Centaurea solstitialis*)	E	X	X	X	X
Diffuse knapweed	(*Centaurea diffusa*)	E	X	X	X	X
Spotted knapweed	(*Centaurea stoebe* spp. *micranthos*)	E	E	X	X	X
Squarrose knapweed	(*Centaurea virgata*)	E	X	X	X	X

Table 5. Herbicides for Noxious and Invasive Weed Species Control

Common Name	Scientific Name	Aminopyralid	Glyphosate	Imazapic	Imazapyr	Chlorsulfuron
Canada thistle	(*Cirsium arvense*)	E	G	X	X	G
Bull thistle	(*Cirsium vulgare*)	E	E, G	X	X	G
Poison hemlock	(*Conium maculatum*)	F	E, G	X	G	X
Field bindweed	(*Convolvulus arvensis*)	F	G, F	X	X	X
Houndstongue	(*Cynoglossum officinale*)	F	X	X	X	X
Bermudagrass	(*Cynodon dactylon*)	P	G	X	X	X
Common teasel	(*Dipsacus fullonum*)	F	G	X	X	X
Russian olive	(*Elaeagnus angustifolia*)	F	G	X	G	X
Quackgrass	(*Elymus repens*)	P	G	X	X	X
Leafy spurge	(*Euphorbia esula*)	F, P	G, F	G	X	X
Myrtle spurge	(*Euphorbia myrsinites*)	F	G	X	X	X
Dyers woad	(*Isatis tinctoria*)	F	G	G	X	G
Perennial pepperweed	(*Lepidium latifolium*)	F	G	G	X	G
Dalmation toadflax	(*Linaria dalmatica*)	F, P	G	G	X	G
Purple loosestrife	(*Lythrum salicaria*)	G	G	X	X	X
Scotch thistle	(*Onopordum acanthium*)	E	X	G	X	G
Phragmites	(*Phragmites australis*)	X	G	X	G	X
Buffalobur	(*Solanum rostratum*)	P	X	X	X	X
Johnsongrass	(*Sorghum halepense*)	P	E, G	X	X	X
Tamarisk	(*Tamarix ramosissima*)	X	G?, X	X	X	X
Medusahead	(*Taeniatherum caput-medusae*)	P	G	X	X	X
Puncturevine	(*Tribulus terrestris*)	F	E	G	X	G

Note: E = excellent, G = good, F = fair, P = poor, X = unrated.

3.5.7.4 Hand Pulling

Removing plants by hand pulling to uproot the plant works well for small infestations of annual and biennial plants provided that the plant species do not resprout from residual roots. Pulling does not generally remove the entire root system, and is ineffective for killing rhizomatous weed species. Species that are good candidates for hand pulling include Dalmatian toadflax, jointed goatgrass, musk thistle, puncture vine, Scotch thistle, bull thistle, Dyer’s woad, and myrtle spurge. Hand pulling is the preferred method for weed removal directly adjacent to the Jordan River.

Salt Lake City has participated in numerous successful weed-pulling events such as the Bag of Woad and Purge Your Spurge, and the Jordan River Parkway portion of the project area provides numerous opportunities for additional public involvement and education.

3.6 Excavation

Excavation is required for the creation of graminoid slope wetland, emergent benches, and off-channel wetlands. It is best to excavate a site following weed treatment to reduce the weed seedbank and root fragments in the topsoil. To prevent root damage, excavation at the base of large trees will be avoided. The topsoil layer will be removed intact and stored onsite until the excavation is complete. Following excavation, topsoil will be returned to the site. Excavation on the RA could take place during construction of the Athletic Complex to reduce costs.

3.7 Revegetation

3.7.1 Seeding

It is important that sites are correctly seeded with the appropriate seed mix or the annual grasses will quickly recover and occupy openings (Monsen 2004). Successful extensive native grass and forb establishment is known to take three to five years following initial seeding. In order to reduce the establishment of undesirable weedy plant species, liquid fertilizer will not be added to seeded areas (USDA 2004).

3.7.2 Planting

Perennials must be planted on sites dominated by cheatgrass and other weedy species to obtain a diverse community of native plant species. If perennial seedlings survive the first growing season, they will usually attain dominance. After the second or third growing season, the perennials should be fully established, and mature in six years if properly managed. A list of suitable species for both planting and seeding in each habitat type is provided in Appendix 3.

In the upland shrubland habitat, 800 shrub seedlings will be planted per acre, where necessary, for approximately 30% shrub cover. A 50% mortality rate should be expected when planting most bare root and containerized shrub seedlings; however, mortality can be minimized with irrigation and maintenance in the first season (USDA 2004). In the spring, bare root shrubs will be kept moist and cool throughout the planting process to avoid root desiccation. At the time of planting, organic soil amendments (topsoil and/or compost) will be added to the planting holes as well as around the base of each seedling. On slopes requiring seeding and shrub installation, the shrubs will be planted prior to seeding.

3.7.3 Seasonal Timing of Seeding/Planting Efforts

All seeding and planting activities will take place in the early spring or late fall when air temperatures are lower and the chance of precipitation is high (USDA 2004). Spring seeding and planting allow plants to become well established by the end of the first growing season, which increases plant survivability.

3.7.4 Planting Pole Cuttings

Cuttings from cottonwoods and willows provide an alternative to transplants. For pole cuttings used in riparian restoration projects, it is important that they are harvested and planted while dormant (early winter to early spring). Branches will be removed, except for a few at the top of the cutting. Vigorous young poles with larger diameters (1 to 2 inches) will establish more readily and successfully than older or skinnier poles. The stump ends of poles will be kept hydrated between harvesting and planting.

Traditional pole cuttings are cottonwoods or willows used to establish the overstory structure of riparian forests. Another cutting type is a small branch (1 to 2 inches in diameter) used typically for streambank plantings; it typically includes thicket or shrub-forming coyote willow. The use of clonal stock can limit genetic diversity and result in the production of unisexual pole cuttings.

Beavers can cause substantial damage to riparian plantings. The presence of beavers thus necessitates the installation of five-foot-high poultry wire tree guards around individual pole plants as well as protection of unplanted poles placed in streams or ditches for hydration. Controlling infestations of defoliating insects may be crucial for pole plantings during the initial growing seasons; cottonwood leaf beetle outbreaks will require control.

3.8 Permanent Water Sources and Temporary Irrigation

Water-dependent habitat types, especially off-channel wetlands, can be designed with a permanent hydrology. Potential water sources available onsite include groundwater, deep well water (estimated at 1,000,000 gpd), culinary water (12-inch and 8-inch lines) and return flow from the Salt Lake City wastewater treatment plant (some of which can also be applied on the sports fields). Separate from these sources but equally important is temporary irrigation needed for plant establishment. During the fall and spring plantings, shrubs will be watered by an irrigation system immediately following planting to aid in successful establishment. For spring plantings, supplemental water will be necessary to ensure seedling success. Shrubs and seedlings will be watered at least once a week during the first growing season. Seeded areas will be watered by a temporary irrigation system for two years following installation. Deep watering of all seedings and plantings in subsequent months will ensure that roots grow downward into the soils to connect with existing groundwater supplies. Created wetland areas will be saturated for up to a month during establishment. Additional water schedules will be determined on a site-specific basis by determining health of plants and competition from invasive species.

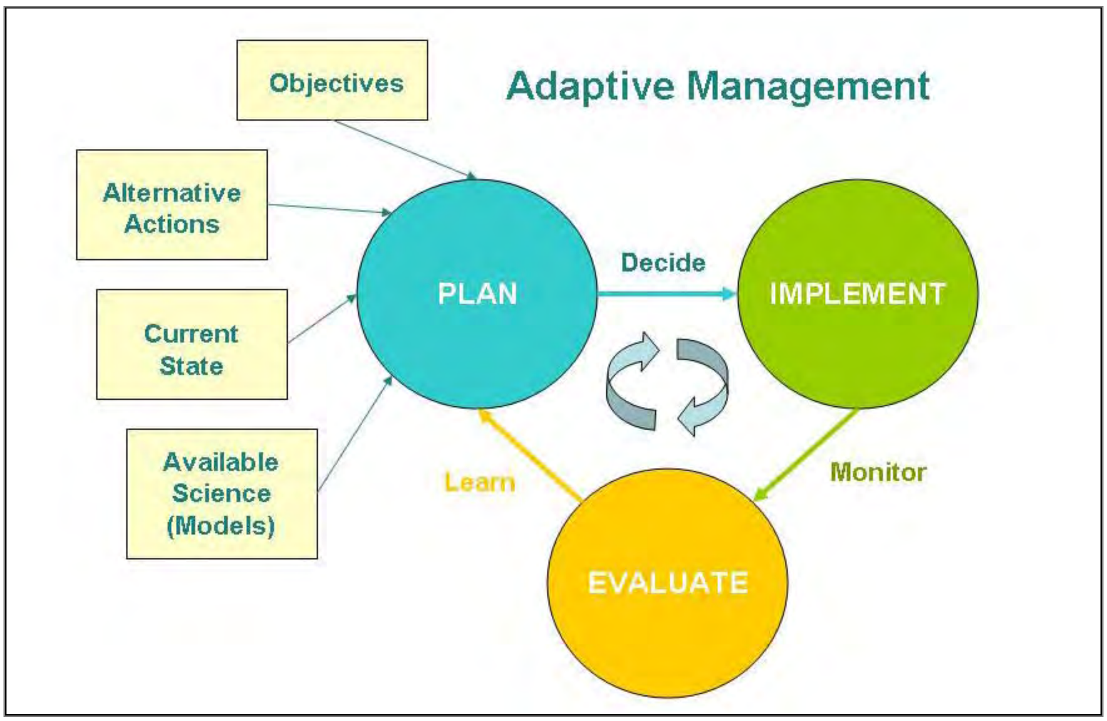
3.9 Riparian Ecosystem Restoration Checklist

- Create a restoration plan that establishes goals and objectives for the site.
- Select specific sites to be restored based on the resources available.
- Collect data on the site's current state (i.e., soil properties, bank stability, channel cross sections, percent cover of various plant, shrub and tree species, water quality and flow data).
- Determine the causes of the riparian degradation and do what is possible to reduce or eliminate the causes (work with landowners upstream of the site if possible).
- Determine the level of restoration effort necessary to establish a healthy, properly functioning riparian ecosystem.
- Obtain all required state, county, and city permits.
- Create an implementation and management plan.
- Install fences and berms around the RA.
- Implement streambank stabilization techniques where necessary.
- Control weeds with mechanical (pulling and possibly goat grazing) and aquatic approved chemical methods.
- Plant poles (willows, cottonwoods, etc.) and plugs, and seed the area with native plants to reduce weed invasion.
- Irrigate newly planted riparian vegetation.
- Monitor and maintain restoration effort for a minimum of five years.

4.0 Monitoring and Maintenance

4.1 Adaptive Management Strategy

Adaptive management is a process used to make decisions about restoration strategies when it is uncertain what the most successful strategies might be. Adaptive management recognizes that ecosystems are extremely complex and dynamic entities. Every restoration site on the Jordan River has unique characteristics that make it impossible to implement the same restoration plan at all sites. Because of this uncertainty, it is essential that we monitor the results of our management actions and alter or adapt the management approach over time if it does not appear to meet management objectives. Adaptive management is necessary to achieve the goals of improved wildlife habitat and water quality through restoration of native vegetation in the RA.



4.2 Monitoring

The purpose of restoration monitoring is to compare findings from year to year to estimate the ecological success of restoration activities and identify patterns of change over time. General monitoring requirements for migratory birds, weeds, and native vegetation are outlined below. Table 6 provides the survey windows and costs for each type of survey.

Table 6. Timing and Costs for Migratory Birds, Weeds, and Vegetation Surveys

	Survey Timing	Duration	Cost (per year)
Breeding Bird Survey	May 15–July 15	2010–2014	$4,000
Bird Migration Survey	May 1–15 and September 1–15	2010–2014	$4,000
Weed Mapping	April 1–15	2010–2014	$3,000
Native Vegetation Survey	June–August	2010–2014	$4,000

4.2.1 Migratory Birds

Migratory bird presence can be measured during summer months using standard point counts to estimate relative abundance of birds, or using area counts to allow mapping of bird distributions in relation to restoration efforts. Monitoring bird communities in the RA prior to restoration, and annually for five years following restoration provides a quantitative measure of restoration success. Increases in abundance and diversity of riparian bird species will demonstrate that the overall restoration goals are being met.

4.2.2 Weeds

Establishing a strong monitoring program that can be easily followed and repeated will greatly assist in future efforts to make appropriate management decisions. Monitoring will include careful documentation of existing weed infestations and control agent release sites, and be designed to capture changes in plant performance and plant populations.

4.2.3 Native Vegetation

Monitoring will take place annually at the same time each summer for the first five years following restoration. Proper measurements will be taken to provide information about which grass, forb, and shrub species are most successful in various biophysical conditions (soil condition, slope, aspect, etc.). If possible, long-term monitoring should continue at select sites once every five years for 50 years or more (Bainbridge 2007). Long-term monitoring and analysis of restoration would make future restoration (both onsite and offsite) less costly and more successful. At sites where shrubs are planted, the number of living and dead transplants will be recorded.

4.2.4 Evaluating Revegetation Efforts

Restoration efforts are evaluated using quantitative metrics selected to measure progress toward each of the restoration objectives. If revegetation is not successful in certain areas, those areas must be carefully evaluated to determine the cause of failure. It is extremely important to write up the results of all restoration efforts, including the failures. These results should be publicly accessible by other restoration practitioners (Bainbridge 2007). Once the cause of failure is determined, the situation should be documented and remedied (if, and where, possible) and the area revegetated. Possible conditions that could contribute to failure include: insufficient soil nutrients, lack of erosion control measures, insufficient protection from wildlife, improper shrub installation, lack of water, extreme precipitation events and extreme air temperatures. Of these conditions, the first five are preventable, while the latter two are not. The following sections provide some general guidelines for evaluation of upland and riparian/wetland restoration sites.

4.2.4.1 Upland Areas

A useful indicator of revegetation success is the mortality rate of planted shrubs. A 25-50 percent mortality rate is to be expected when planting most containerized shrub seedlings (Bainbridge 2007). Another useful indicator of revegetation success is the establishment of seeded native grasses and forbs. Extensive native grass and forb establishment is known to take three to five years following the initial seeding. The seeding will be considered successful if a significant increase in the number and type of native species are observed each year, with substantial increases in native plant biomass and diversity after three years.

4.2.4.2 Riparian and Wetland Areas

In general, revegetation of riparian and wetland restoration sites is easier than upland sites because water is readily available. Expected mortality rates for plantings in riparian and wetland areas is a useful indicator of restoration success. A successful pole planting usually results in 70-100 percent of poles surviving. Brush plantings, however, are considered successful if the survival rate is greater than 40 percent (Bentrup and Hoag 1998).

4.3 Maintenance

In keeping with adaptive management, findings from on-going monitoring activities will inform maintenance requirements. For example, plant mortality may necessitate irrigation, replanting or better surveillance to control access or predation by herbivores. Similarly vegetation monitoring will identify areas where invasive weeds are taking hold. The presence of these species will initiate weed management activities. Finally, more general maintenance will address issues of access, litter and vandalism. After construction and during the monitoring period, maintenance will occur on a monthly basis and after large rain and runoff events to insure that all aspects of the site are functioning properly and that no damage from erosion, vandalism, or predation has occurred. Salt Lake City will perform necessary maintenance on the RA.

5.0 Data Needs for Restoration Implementation

A detailed implementation and management plan must be written prior to any streambank modification, weed treatment, or planting occurs in the RA. The implementation and management plan will provide a detailed planting plan, seed mixes, irrigation design, and streambank modification construction drawings. It will also provide cost and availability of specific plants and seed mixes as wells as detailed monitoring and maintenance protocols.

5.1 Vegetation Monitoring Data

Vegetation monitoring data must be collected in May or June prior to weed treatment or planting. The results of the monitoring will be used in the creation of the implementation and management plan for the RA. This information will also serve as a baseline for comparison with vegetation monitoring data collected annually following restoration. This information is crucial for identifying the locations of noxious and invasive weed infestations that will dictate treatment effort timing and herbicide needs. It is also necessary for determining number and location of restoration plantings.

5.2 Weed Mapping

For this project, high-priority weed infestations will be mapped and evaluated to determine the most appropriate treatment method for each. Mapping will include recording the size, density, and composition of weed infestations. This information could then be used to determine the treatment type necessary for each weedy infestation as well as provide a baseline for future monitoring efforts.

5.3 Pricing and Availability of Seed and Plants

The current price and availability of native seed mixes and plants must be determined no more than one month prior to creation of the implementation and monitoring plan. If specific plants are desired but not available, many can be contract grown by contacting the nursery at least ten months in advance. This will ensure that the plants and seed described in the plan will be available for installation when needed.

5.4 Soil Data

The non-uniform layering of sand and clay in the RA soil profile will require that soil samples be collected and analyzed in both the wetland and upland RAs.

5.5 River Cross Sections

Cross sections are necessary to adequately determine the proper placement of recontoured sections. Two or three cross sections will be needed for each 100-yard section of recontoured streambank.

5.6 Groundwater Monitoring Wells

Shallow groundwater monitoring wells will be needed to assess the depth to groundwater in areas where off-channel wetland creation or enhancement is planned. These wells will be installed in areas where vegetation and soil auger holes indicate that the depth to groundwater can support wetland vegetation with minimal excavation.

5.7 Locations of Short- and Long-term Irrigation Sources

Creation of an implementation and management plan requires accurate knowledge of available sources for short- and long-term irrigation of restoration seeding and planting efforts. For this project, information on water availability from the Jordan River, shallow ground water, well water, culinary water (only necessary if other sources have poor water quality), and wastewater treatment effluent are required. Quantification of water rights and their associated points of diversion are also required.

5.8 Anticipated River Access Requirements

It is necessary to know the locations and sizes of required emergency river access points on both the east and west side of the Jordan River in the RA. This information will be incorporated into the restoration site design.

6.0 Educational Access and Interpretation

The installation of interpretive signage at the trailhead along the east side of the Jordan River in the RA will provide educational opportunities and help foster environmental stewardship through better understanding of the ecology of the Jordan River. A multi-paneled, kiosk-type sign at the trailhead will feature interpretive material on native plants, wildlife and, noxious weeds. The information depicted on the signs could be designed to complement the historical and/or ecological curriculum of local schools, including the nearby middle school. The signage developed for this section of the Jordan River Trail could be incorporated into a comprehensive sign plan for the Trail System. The following elements should be considered when developing signage on the fringes of urban development.

- Interpretive signs will be designed to blend in with the natural environment. Sign design and material should be unique to the surroundings and the theme should be incorporated throughout the trail system.
- Signs will be made of a durable material that can withstand fluctuations in seasonal temperature, sunlight, and vandalism.
- Signs will be clustered around park features, trails, and trailheads to avoid additional disturbance to natural areas.
- Information should be presented on an eighth grade reading level in order to appeal to a broad range of users.
- Based on current (2010) interpretive sign design, construction, and installation costs, high-quality interpretive signs cost approximately $15,000 each to design and build. A kiosk with three signs and a covered picnic table costs approximately $50,000 to design and build.

Regional Athletic Complex
Natural Area
N
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0 400 800 Feet
Imagery taken from AGRC's High Resolution Ortho-Photography (HRO) 1-foot resolution color aerial photography, 2009.
SWCA ENVIRONMENTAL CONSULTANTS
Monday, March 1, 2010 10:18:50 AM
Woods Cross
North Salt Lake
Mueller Park
Davis County
Salt Lake City
South Salt Lake
Canyon Rim
West Valley City
USA World Street Map, ESRI Online Service (© 2009 ESRI, AND, TANA, ESRI Japan, UNEP-WCMC)

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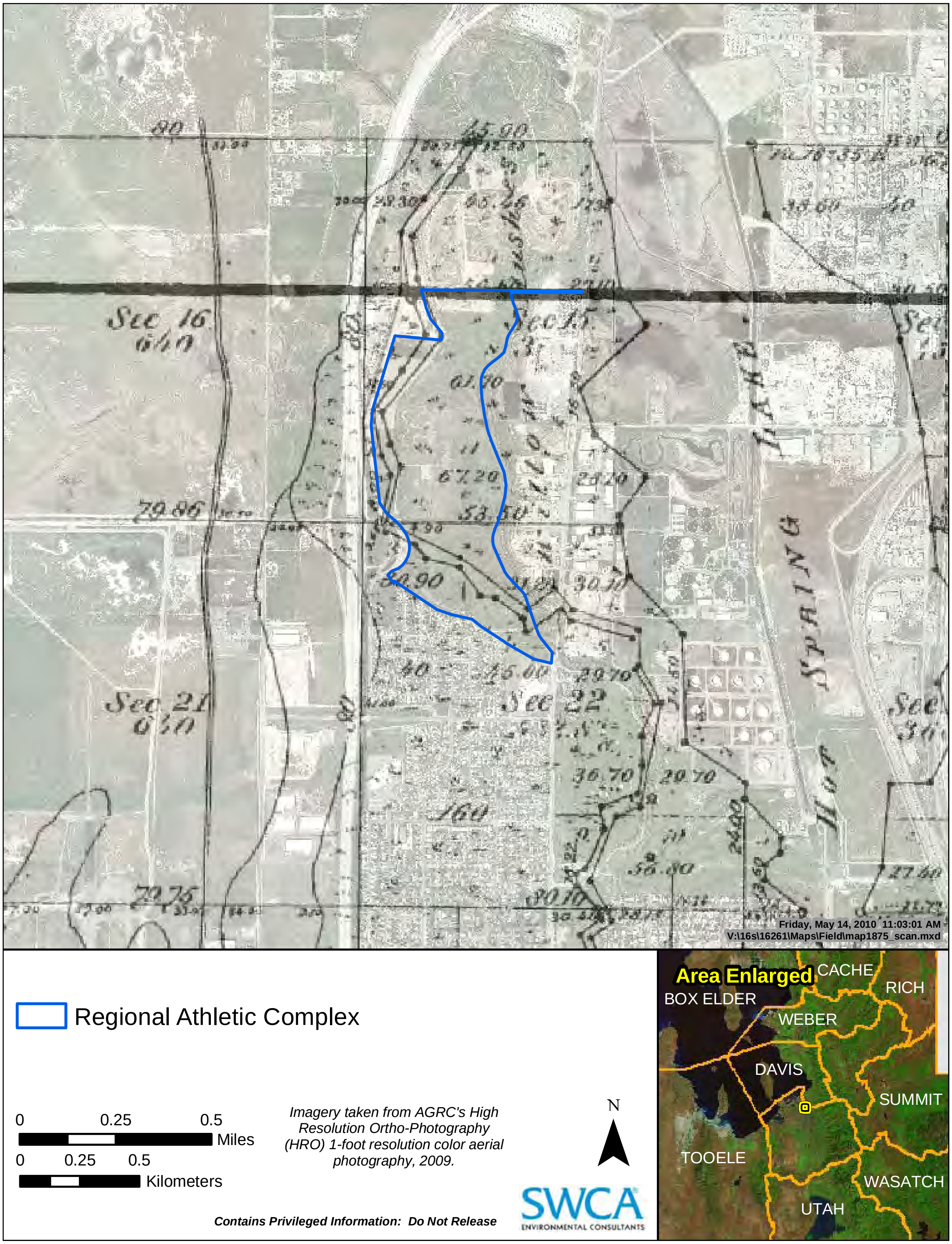

Map 2. Historical site map.

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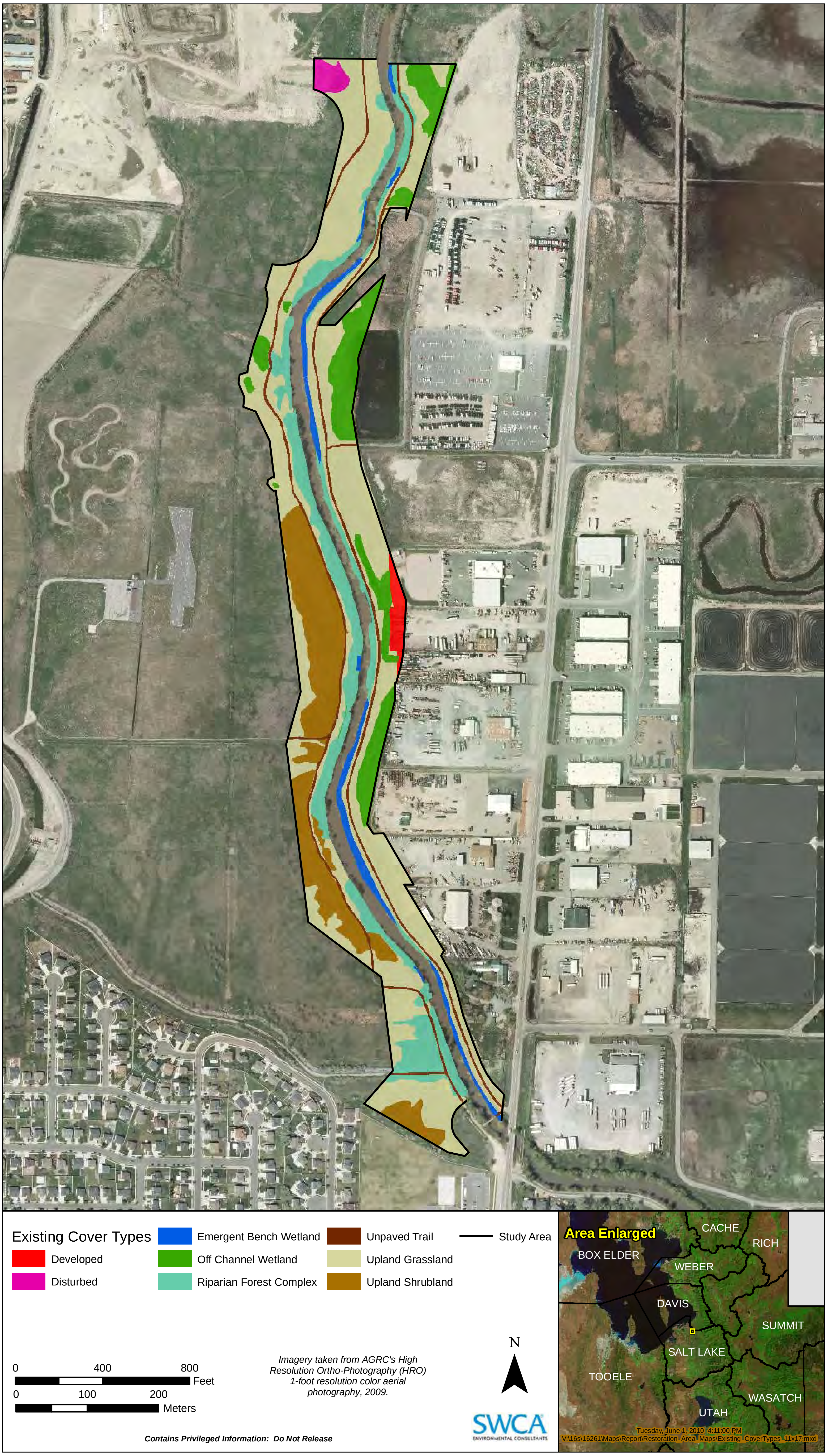

Map 3. Existing conditions in the RA.

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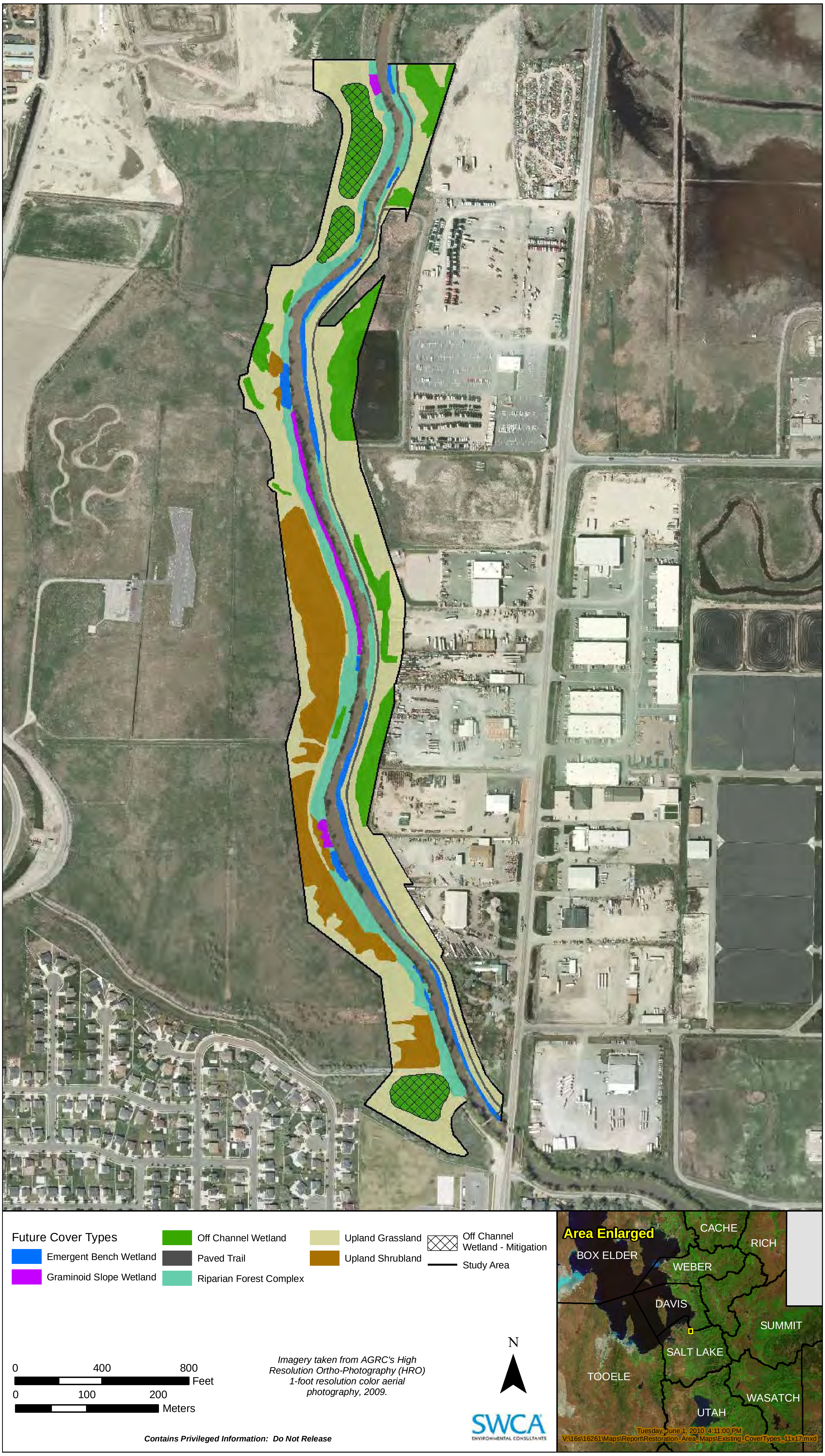

Map 4. Future conditions in the RA.

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Appendix 1: Bird List

Shaded species were observed in the Project Area during surveys conducted by UDWR (Utah Division of Wildlife Resources 2003).

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
Sharp-shinned Hawk	*Accipiter striatus*	large stands of deciduous, coniferous and mixed pine-hardwoods, dense vegetation.	Conifer, decid tree	Potential nester	C	P	b	No
Cooper's Hawk	*Accipiter cooperi*	Deciduous, mixed, and evergreen forests and deciduous stands of riparian habitat.	Decid tree, conifer	Potential nester	C	P	b	No
Swainson's Hawk	*Buteo swainsoni*	Typically nests in scattered trees within grasslands, shrubs, along stream courses	Decid tree, cliff	Observed	C	S	a	No
Red-tailed Hawk	*Buteo jamaicensis*	Typically breeds in open to semi-open habitats. Avoids densely timbered areas.	Platform	Observed	C	P	b	No
American Kestrel	*Falco sparverius*	Attracted to human-modified habitats, pastures, parkland.	Snag, cliff	Observed	C	P	b	No
Mourning Dove	*Zenaida macroura*	Wide array of ecosytems.	Decid tree, conifer,	Observed	C	S	b	No

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
			ground					
Common Nighthawk	*Chordeiles minor*	Woodland clearings, prairies, sagebrush, open forest. Uses river valleys/river during migration	Ground	Potential nester	C	S	a	No
White-throated Swift	*Aeronautes saxatalis*	Nests in crevices in cliffs, canyon walls, freeway overpasses, bridges. Occurs in mountainous and hills associated with open country and forested areas. Occasionally observed flying near open ponds.	Cliff	Potential during migration	C	S	a	No
Black-chinned Hummingbird	*Archilochus alexandri*	Canyons or flood-plain riparian, with willows, cottonwoods.	Decid tree	Potential nester	C	S	a	No
Calliope Hummingbird	*Stellula calliope*	Often associated with aspen thickets along running stream, open montane forest	Conifer, decid tree, shrub	Potential during migration	U	S	a	No

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
Belted Kingfisher	*Ceryle alcyon*	Variety of aquatic habitats, streams, rivers, ponds,needs a nearly vertical earthern exposure for digging nesting burrows.	Bank, snag	Potential nester	U	P	b	No
Northern Flicker	*Colaptes auratus*	Open woodlands, savannas, and forest edges	Snag	Observed	C	P	b	No
Olive-sided Flycatcher	*Contopus borealis*	Forest edges and openings, natural edges of marshes and open water	Conifer	Potential during migration	C	S	a	No
Western Wood-pewee	*Contopus sordidulus*	Open forest, forest edge and riparian zones	Conifer	Potential nester	C	S	a	No
Willow Flycatcher	*Empidonax trailii*	Occupies shrubby, river corridors	Decid tree, shrub	Potential nester	C	S	a	No
Western Kingbird	*Tyrannus verticalis*	Open habitats scattered with trees. Forages for insects from open perch	Decid tree, shrub	Observed	C	S	a	No
Plumbeous Vireo	*Vireo plubeus*	Dry, open pine forests	Conifer, decid tree	Potential during migration	C	S	a	No

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
Warbling Vireo	*Vireo gilvus*	Large trees near water, cottonwoods, aspen	Decid tree, shrub	Potential nester	C	S	a	No
Purple Martin	*Progne subis*	Open habitat	Man-made	Potential during migration	R	S	a	No
Tree Swallow	*Tachycineta bicolor*	Open areas near water, fields, marshes, shorelines, wooded swamps	Snag	Potential nester	C	S	b	No
Violet-green Swallow	*Tachycineta thalassina*	Open deciduous, coniferous, and mixed woodlands	Snag	Potential nester	C	S	a	No
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Open areas, especially near ponds, rivers, woodlands.	Bank, cliff, culvert	Potential nester	C	S	a	No
Bank Swallow	*Riparia riparia*	Lowland areas near rivers, streams, lakes, and wetlands	Bank	Potential nester	C	S	a	No
Cliff Swallow	*Petrochelidon pyrrhonota*	Historically open canyons, foothills, river valleys, presently also in grasslands, riparian edge, broken forests	Bridge, cliff, building	Observed	C	S	a	No

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
Barn Swallow	*Hirundo rustica*	Fields, ponds, open areas, agricultural areas	Man-made structures	Observed	C	S	a	No
Brown Creeper	*Certhia americana*	Mature woods, wet shaded areas	Conifer, decid tree	Potential nester	U	P	b	No
House Wren	*Troglodytes aedon*	Dense brushy patches, shrubby woodlands	Decid tree, snag	Observed	C	S	a	No
Ruby-crowned Kinglet	*Regulus calendula*	Wooded areas, coniferous, low brush or deciduous	Conifer	Observed	C	P	b	No
Blue-gray Gnatcatcher	*Polioptila caerula*	Brushy woods or thickets	Decid tree	Observed	C	S	a	No
Mountain Bluebird	*Sialia currucoides*	Open areas scattered with trees	Snag	Potential nester	C	S	b	No
Swainson's Thrush	*Catharus ustulatus*	Mature mixed woods, coniferous, riparian woodland	Shrub, conifer	Potential during migration	C	S	a	No
Hermit Thrush	*Catharus guttatus*	Forest, forest edge, brushy understory	Ground, tree	Potential nester	C	S	b	No
American Robin	*Turdus migratorius*	Any open woodland	Decid tree, conifer	Observed	C	P	b	No
Gray Catbird	*Dumetella carolinensis*	Brushy understory of woods, often in damp shaded areas.	Shrub	Potential during migration	R	S	a	No

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
Cedar Waxwing	*Bombycilla cedrorum*	Open woodland and old field habitats, with shrubs and small trees.	Decid tree, conifer	Potential during migration	R	S	b	No
Orange-crowned Warbler	*Vernivora celata*	Dense brushy deciduous areas	Ground, shrub	Potential nester	C	S	a	No
Yellow Warbler	*Dendroica petechia*	Wet brushy area, willow thickets	Shrub, tree	Observed	C	S	a	No
Yellow-rumped Warbler	*Dendroica coronata*	Open coniferous forests and edges	Conifer	Observed	C	S	b	No
MacGillivray's Warbler	*Oporonis tolmiei*	Dense brushy deciduous patches near water	Shrub, ground	Potential nester	C	S	a	No
Common Yellowthroat	*Geothlypis trichas*	Weedy, brushy, and marshy habitats, nearly always in wet areas	Shrub	Potential nester	C	S	a	No
Wilson's Warbler	*Wilsonia pusilla*	Brushy woods with dense understory near water	Ground, vine tangle	Potential nester	C	S	a	No
Yellow-breasted Chat	*Icteria virens*	Dense tangled brushy patches and hedgerows in open sunny areas	Shrub	Potential nester	C	S	a	No

Tier I. Neotropical Migrants

Common Name	**Scientific Name**	**Habitat**	**Nest Location**	**Presence in Project Area**	**Abundance**	**Status**	**Class**	**Priority Species?**
Western Tanager	*Piranga ludoviciana*	Coniferous and deciduous woods.	Conifer	Potential nester	C	S	a	No
Chipping Sparrow	*Spizella passerina*	Open woodlands and woodland edges	Conifer, decid tree	Potential nester	C	S	a	No
Fox Sparrow	*Passerella iliaca*	Thick cover, especially brushy woodland edges, scrubby woods	Ground, shrub	Potential nester	U	S	b	No
Song Sparrow	*Melospiza melodia*	Brushy areas near water	Ground, shrub	Observed	C	P	b	No
Lincoln's Sparrow	*Melospiza lincolnii*	Dense brushy areas	Ground	Observed	C	S	a	No
White-crowned Sparrow	*Zonotrichia leucophrys*	Patchy brushy areas	Ground	Observed	C	S	b	No
Dark-eyed Junco	*Junco hyemalis*	Open coniferous forests or mixed woods with patches of open ground	Ground, bank	Potential nester	C	P	b	No
Black-headed Grosbeak	*Pheucticus melancephalus*	Mature deciduous woods, or wooded brushy habitats	Decid tree, shrub	Potential nester	C	S	a	No
Lazuli Bunting	*Passerina amoena*	Brushy or weedy habitats, especially along streams in arid regions	Shrub, vine tangle	Potential nester	C	S	a	No

Tier I. Neotropical Migrants

Common Name	Scientific Name	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class	Priority Species?
Bullock's Oriole	*Icterus bullockii*	Deciduous trees in or near open areas	Decid tree	Observed	C	S	a	No
Lesser Goldfinch	*Carduelis psaltria*	Patchy open habitat	Decid tree, shrub, forb	Potential nester	C	S	b	No
American Goldfinch	*Carduelis tristis*	Weedy and grassy fields and flood plains	Shrub, tree	Potential nester	C	P	b	No
Virginia's Warbler	*Vernivora virginiae*	Dense brushy undergrowth with scattered trees.	Ground	Potential nester	C	S	a	Yes
Bobolink	Dolichonyx oryzirvorus	Agricultural fields, wet meadows	Ground	Potential nester		S	a	Yes
Long-billed Curlew	*Numenius americanus*	Nest on dry grasslands	Ground	Potential nester	U	S	a	Yes
Broad-tailed Hummingbird	*Selasphorus platycercus*	Aspen, subalpine meadows and shrubby habitats with nearby forests	Decid tree, conifer	Potential nester	C	S	a	Yes
Black-throated Gray Warbler	Dendroica nigrescens	Pinyon-juniper, migrates through riparian areas	Conifer, decid tree, shrub	Potential during migration	C	S	a	Yes
Yellow-billed Cuckoo	*Coccyzus americanus*	Often associated with watercourses, open woodlands w/clearings, low, dense, scrubby vegetation	Decid tree, shrub	Potential nester	R	S	a	Yes

The priority species are from the list from Utah Partners in Flight Avian Priority Species, (2002).

Tier II. Non Neotropical Species

Common Name	***Scientific Name***	**Habitat**	**Nest Location**	**Presence in Project Area**	**Abundance**	**Status**	**Class**
Double-crested Cormorant	*Phalacrocorax auritus*	Exposed rocks, sandbars, trees for perching. Most forage in shallow water < 8 meters	Platform	Yes	U	S	m
Great Blue Heron	*Ardea herodias*	Feeds mostly in slow moving or calm freshwater. Nests in trees, bushes, on ground and artificial structures. Prefers island (predator avoidance?)	Platform	Yes	C	P	p
Black-crowned Night Heron	*Nycticorax nycticorax*	Swamps, streams, rivers, wetlands, lakes, canals and wet agricultural fields.	Decid tree, shrub	Yes	C	S	p
Osprey	*Pandion haliaetus*	Diverse habitat but needs adequate supply of fish within 20 km of nest, shallow waters, open nest sites	Decid tree, cliff	Potential to forage in area	R	S	m
Bald Eagle	*Haliaeetus leucocphalus*	Breeds in forested areas adjacent to bodies of water	Conifer, cliff	Potential to forage in area	R	S	p
Black-billed Magpie	*Pica hudsonia*	Prairies and parklands with scattered trees. Open woodlands	Decid tree, shrub	Yes	C	P	p
White-breasted	*Sitta carolinensis*	Mixed deciduous and	Decid tree	Potential	U	P	p

Tier II. Non Neotropical Species

Common Name	*Scientific Name*	Habitat	Nest Location	Presence in Project Area	Abundance	Status	Class
Nuthatch		coniferous forest occasionally in residential areas		nester			
Western Screech-Owl	*Megascops kennicottii*	Variety of woodland and forest habitats, with higher densities in riparian woodlands	Snag	Potential nester	U	P	p
Great Horned Owl	*Bubo virginianus*	Desert, grassland, suburban and forest habitats	Decid tree, cliff	Potential nester	C	P	p
Spotted Sandpiper	*Tringa solitaria*	Ponds and streams, particularly on rocky shores and steep banks.	Ground	Potential nester	C	S	m
Downy Woodpecker	*Picoides pubescens*	Open, deciduous, especially riparian, woodlands	Snag	Yes	C	P	p
Hairy Woodpecker	*Picoides villosus*	Mature woodlands, can occur in small woodlots, parks, urban areas with mature shade trees	Snag	Potential nester	C	P	p

Known occurrences (shaded rows) are species documented by Utah Division of Wildlife Resources field surveys from 2002 and 2003 (UDWR 2003)

Abundance (Utah Ornithological Society 1998)

C = Common (Found consistently in fair numbers in appropriate habitat and season).

U = Uncommon (Found occasionally in small numbers in appropriate habitat and season).

R = Rare (Found infrequently but regularly in very small numbers in proper habitat and season).

Status (Utah Ornithological Society 1998)

P = Permanent resident (Found year round in state)

S = Summer Resident (Present in the state during the nesting season).

Class-Migratory Bird Classification (Howe 1996, Gauthreaux 1992).

m = Species that breed in Utah and migrate during the nonbreeding season but are not considered to be Neotropical Migratory Birds

p = Species that are primarily permanent residents in Utah, a proportion of Utah population may migrate

Neotropical Migratory Birds - proportion of Utah population that migrates varies with species and conditions (Gardner et al. 1999).

a = Species that breeds in North America and spend their nonbreeding period primarily south of the U.S.

b = Species that breed and winter extensively in North America although some populations winter south of the U.S.

c = Species whose breeding range is primarily south of the U.S./Mexican border, and enter the U.S. along the Rio Grande Valley and where the Mexican highlands extend across the U.S. border. These populations vacate the United States during the winter months.

Appendix 2: Riparian / Wetland Restoration Cost

Riparian / Wetland Restoration Per Unit Cost

Treatment	Units	Minimum	Maximum
SOIL			
Coconut coir log	linear ft	$ 2.70	$ 3.70
Erosion blanket	square ft	$ 0.17	$ 0.23
Riparian fencing	square ft	$ 2.50	
Riprap rockwork	cubic yard	$ 60.00	
Stream slope grading to 3:1	square ft	$ 0.50	
Soil lifts	linear ft	$ 75.00	
Excavation	cubic yard	$ 1.75	
Material Removal	cubic yard	$ 5.00	$ 7.00
Soil Import	cubic yard	$ 5.00	$ 7.00
PLANTS			
Pole plantings	Each	$ 0.50	$ 5.00
Dormant Cuttings 2' spacing	linear ft	$ 3.74	
30" deep rooted willows	linear ft	$ 10.31	
3-4" Tublings or Bareroot stock	Each	$ 0.79	$ 1.49
Containerized Plants- 2 gallon	Each	$ 8.00	$ 15.00
Containerized Plants- 5 gallon	Each	$ 15.00	$ 39.00
Containerized Plants- 10 gallon	Each	$ 79.00	$ 159.00
Containerized Willows- 1 gallon	Each	$ 2.79	$ 10.00
Containerized Willows- 5 gallon	Each	$ 7.03	
Wetland sod	linear ft	$ 19.05	
SEED			
Wetland Seed (plus installation)	acre	$ 5,590.00	$ 6,450.00
Riparian Seed (plus installation)	acre	$ 3,440.00	$ 4,730.00
Upland Seed (plus installation)	acre	$ 2,580.00	$ 4,730.00
Wetland Sedge Seed	acre	$ 2,200.00	
Wetland Grass Seed	acre	$ 612.00	
Upland Grass Seed	acre	$ 340.00	
IRRIGATION			
Irrigation	square ft	$ 0.15	
WEED TREATMENT			
Goats	acre	$ 450.00	
Herbicide	acre	$ 300.00	$ 400.00

Appendix 3: Plant List

Plant List*

Scientific Name	Common Name	Type	Upland	Riparian	Wetland
Acer grandidentatum	bigtooth maple	Tree	x	x	
Acer negundo	box elder	Tree		x	x
Achnatherum hymenoides	Indian ricegrass	Grass	x		
Artemisia tridentata	big sagebrush	Shrub	x		
Astragalus utahensis	Utah ladyfinger milkvetch	Forb	x		
Atriplex confertifolia	shadscale	Shrub	x		
Atriplex gardneri	Gardner's saltbush	Shrub	x		
Calamagrostis canadensis	bluejoint reedgrass	Grass		x	
Carex aquatilis	water sedge	Forb		x	
Carex pellita	wooly sedge	Forb			x
Carex nebrascensis	Nebraska sedge	Forb		x	x
Castilleja angustifolia	Indian paintbrush	Forb	x		
Cercocarpus ledifolius	curl-leaf mountain mahogany	Tree	x		
Chrysothamnus viscidiflorus	twistedleaf rabbitbrush	Shrub	x		
Cornus sericea	red-osier dogwood	Shrub		x	
Crataegus rivularis	river hawthorn	Shrub	x	x	
Deschampsia caespitosa	tufted hairgrass	Grass			x
Eleocharis palustris	common spikerush	Forb		x	x
Elymus trachycaulus	slender wheatgrass	Grass	x		
Eriogonum umbellatum	sulfurflower buckwheat	Forb	x		
Fallugia paradoxa	Apache plume	Shrub	x		
Geranium viscosissimum	sticky geranium	Forb	x		
Hedysarum boreale	Utah sweetvetch	Forb	x		
Iliamna rivularis	maple mallow	Forb	x		
Juncus arcticus	wiregrass	Forb		x	x
Juncus torreyi	Torrey's rush	Forb		x	x
Leymus cinereus	basin wildrye	Grass	x		
Pascopyrum smithii	western wheatgrass	Grass	x		
Penstemon palmeri	Palmer penstemon	Forb	x		
Penstemon utahensis	Utah penstemon	Forb	x		
Populus angustifolia	narrowleaf cottonwood	Tree		x	
Populus fremontii	Fremont's cottonwood	Tree	x	x	
Prunus virginiana	chokecherry	Tree	x	x	
Puccinellia nuttalliana	Nuttal's alkaligrass	Grass			x

Plant List*

Ribes aureum	golden currant	Shrub	x	x	x
Rhus trilobata	oakleaf sumac	Shrub	x		
Rosa woodsii	Woods' rose	Shrub		x	x
Salix amygdaloides	peachleaf willow	Tree		x	x
Salix exigua	coyote willow	Shrub		x	x
Salix lutea	yellow willow	Shrub		x	
Schoenoplectus acutus	hardstem bulrush	Forb		x	
Schoenoplectus maritimus	alkali bulrush	Forb			x
Schoenoplectus pungens	threesquare bulrush	Forb		x	x
Sphaeralcea grossulariifolia	gooseberryleaf globemallow	Forb	x		
Sporobolus airoides	alkali sacaton grass	Grass	x		x
Tetraneuris acaulis	sundancer daisy	Forb	x		

*USDA Plants Database 2010